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TECHNOLOGY TRANSFER IN POLAND: AN INVESTIGATION OF U.S. GOVERNMENT, U.S. CORPORATE, AND POLISH GOVERNMENT STRATEGIES

THESIS

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My grandmother, Valeria Frances Nowierski, graduated from Incarnate Word College in 1928. Throughout my childhood, she inspired me with stories about her life and my family origins in Russia and Eastern Europe. This thesis is dedicated to her. Those same stories were passed on to my children, April, Alicia, and Amy. I thank them for never losing faith in their mother. My husband, Michael, recognized my potential and patiently helped me in every conceivable way. No words can ever thank him enough. I extend my appreciation to the staff of the Air Force Institute of Technology Library who never flinched and spent time and precious money gathering requested research material from obscure domestic and foreign sources. The technical expertise, guidance, and encouragement supplied by Dr. Craig Brandt, Maj Paul Thurston, and Dr. Jan P. Muczyk in the production of this thesis are both evident and appreciated.

Susan E. Hays

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Abstract

This case study examines how U.S. Government (USG) policy, U.S. corporate policy, and Polish government policy affect the strategy of technology transfer of military and/or dual-use technologies in Poland. The traditional supplier/recipient relationship is explored and found to be insufficient to describe the process associated with military and/or dual-use technology transfer. An alternate model is proposed that accounts for the activities of the USG, U.S. corporations, and the Polish government. These relationships are investigated in the context of six strategies to determine the validity of the model in the case of military and/or dual-use technology transfer to Poland. The analysis provides evidence that in an increasingly globalized economy, appropriate strategies for technology transfer are critical for each participant to attain their particular objectives. Further, these strategies are influenced by intra-participant forces that shape goals and inter-participant relations that both create and inhibit opportunities to transfer technology.

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I. Introduction

Since the fall of the Berlin Wall in 1989, eastern bloc nations have struggled with the introduction of new economic and political policies. Centrally planned economies are giving way to free market economies as government-owned production shifts into private hands (Shama, 1993). The political shift toward democracy requires a corresponding shift in defense policy and force posture as former Warsaw Pact countries prepare for North Atlantic Treaty Organization (NATO) membership. Poland is making this transition, but must introduce new technologies into their business culture to compete effectively in the global economy. This "global economy" is a composite of regional, national, and international economies "linked in an increasingly dense network of economic interactions" (Sachs, 1998:97).

Paired with the economic challenge is Poland's impending admission to NATO where they must also meet the requirements for military integrated command (NATO Handbook, 1995:122). Of particular interest to this research effort is the introduction of military and dual-use technologies that will help Poland meet each of these challenges. Dual-use technologies are those technologies initially designed with no military function,

but with modification may have a military application (DISAM, 1997:510). This "dual-use" technology provides opportunities for the receiving nation (in this case, Poland), but also creates problems (e.g., national security, and loss of competitive advantage) for the supplying nations and firms (e.g., the USG). The ultimate source of these military and/or dual-use technologies will also create problems for the Polish Government as they make decisions between new alliances with the United States and the nations of the European Union (EU).

United States Government defense budgets continue to decline in real terms. At the same time, U.S. defense industrial base corporations have merged in an effort to remain competitive (Gregory, 1997). The armament decisions made by Poland may affect the continued strength of the U.S. defense industrial base as Department of Defense contractors face increased competition for military products in the global economy (Tigner, 1997b). As other eastern European states seek admission to NATO and the European Union and armament sales increase, the USG must have a clear understanding of the political and economic policies that motivate these armament decisions.

The purpose of this research is to develop a model that can help explain the various and often conflicting political and economic influences and relationships that guide the military and/or dual-use technology transfer (T^2) strategies of the USG, defense contractors Lockheed-Martin and Boeing Corporation, the Polish government, and Polish firms.

Background

On April 30, 1998, the U.S. Senate voted to admit Poland to NATO. Provided the remaining parliaments of NATO members vote in favor of the expansion, Poland is

scheduled to enter the alliance in April 1999. As a consequence of admission, Poland must develop a defense posture that serves its national objectives while also carrying out its future roles and missions in the NATO integrated command (NATO Handbook, 1995:105). To integrate properly, Poland will need to adapt its military infrastructure and develop host-nation-support capability and interoperability. To meet these demands, Poland's military will need to modernize (Embassy of Poland,1998). Currently, the Polish Air Force resources are comprised of aging Soviet-made weapons systems, and the transfer of new technologies can play an essential role in the modernization of Polish Air Force. U.S. military technology may serve this need. However, the Polish government must balance any desire for U.S. military technology against the enormous economic costs and growing political pressures from the EU. Poland is seeking admission to the EU and must decide between U.S. weapon systems and competing EU member states military technologies (Erlich & Tigner, 1998).

"The companies that win the contracts to provide that 'inter-operability' to ... [Poland] will benefit enormously from NATO's eastward expansion" (Seelye, 1998). Major U.S. defense contractors, Lockheed-Martin and Boeing Corporation, are prime contenders to transfer military technologies to Poland (Seelye, 1998). Lockheed-Martin possesses the technologies for the F-16, and Boeing can offer the F-15. Notwithstanding that the price tags for these systems are outside the economic capability of Poland's current military funding profiles, both companies seem to approach future arms sales from the standpoint of long-term economic/political investments by establishing "partnerships in Eastern Europe to give the companies a foothold" (Seelye, 1998). Still, these companies must balance their desire for the expanded Polish market against the

possible diffusion of proprietary information. By transferring weapons technology to Poland, U.S. corporations could give rise to a new group of competitors for future foreign military sales and lose additional market share.

The perceived threat to European security has changed significantly since 1989 (Cupitt et al, 1994:3). If the Protocols of Accession to the NATO Treaty are ratified, Poland, a former Warsaw Pact member, will have access to U.S. weapon systems technologies in excess of the aid currently provided through various assistance programs (Department of State, 1995:533; Samelson, 1998). The transfer of these technologies is predicated on combined reviews and/or approvals of the U.S. Departments of Commerce, Defense, Energy, State, and Arms Control and Disarmament Agency (DISAM, 1997:488-492). In these reviews and approvals are vested the national security objectives of the USG. These departments must weigh the increased need of U.S. defense contractors to compete in a global economy and thus strengthen the U.S. industrial base against the need to maintain control of national defense technology.

Research Problem

The complicated nature of international political and economic decision-making by the participants in T^2 is bridged by the need to transfer technology. Poland needs new technologies to energize a growing market economy. Lockheed-Martin and Boeing Corporations must transfer technologies to compete globally for foreign military sales. The transfer of military technologies is supportive of the USG pursuit of security objectives. "At the core…is public policy that focuses on 'technology transfer' - a strategy to accelerate technological innovation through the transfer of new knowledge,

know-how, and advanced technologies from one organization to another, from one sector to another, from one nation to another" (Lee, 1994:260).

These relationships are usually described in terms of the supplier/recipient affiliations (Chiou et al., 1996:6). Suppliers possessing the technical knowledge and recipients seeking specific types of expertise are brought together in the give and take of a negotiated agreement. Given that military or dual-use technology must have USG approval for licensing before companies are allowed to enter into negotiated international agreements, the two-party (i.e. supplier/recipient) relationship does not address all of the important relationships among the participants in T^2. A revised model needs to be designed which can address the relationships for successful international military or dual-use T^2 between the USG, Lockheed-Martin and Boeing Corporations, and Poland.

Investigative Questions. In order to develop and use a revised model, the following investigative questions needed to be answered:

1. What is necessary for a successful T^2?
2. What methods are used for military or dual-use T^2?
3. Do the methods and participants differ when the technology is military and/or dual-use rather than commercial?
4. What political and economic influences affect participant strategies toward transfer of military or dual-use technologies?
5. Can a framework be developed to explain the myriad of participants, relationships, and influences on the T^2 process?
6. Can this framework be used to describe the strategies use and actions taken by the participants of T^2 in Poland?

Scope and Assumptions

International military T^2 between the U.S.S.R. and Poland occurred during the arms buildup of the Cold War (Bertsch, 1983:51) and may continue with Russia as Poland investigates technology proposals from around the world. As Poland has emerged from the Eastern bloc as an independent democratic nation, opportunities for the importation of western military and/or dual-use technologies have been created. In order to place manageable bounds on this research, and to emphasize the initiation and growth of new relationships, only those relationships between the USG, Lockheed-Martin Corporation, Boeing Corporation, the Polish government, and Polish industries will be investigated within a time frame from 1989 through July 1998. The corporate perspective was limited to Lockheed-Martin and Boeing because these U.S. corporations are ranked number one and two in the "Top 100 Worldwide Defense Firms" based on their 1997 defense revenues (Finnegan, 1998b). As such, they are chosen as most representative of on-going efforts for U.S. military and/or dual-use T^2 in Poland.

T^2 can be seen as: (1) a strategy for inserting American influence into Polish markets and "enhancing the desire for U.S. goods and services" (Clinton & Gore, 1993); (2) improving the Polish industrial base by allowing Poland to increase its global competition; and (3) providing Lockheed-Martin and Boeing Corporations a competitive edge over non-domestic technologies in the foreign military sales arena. Viewed from these perspectives, T^2 is a positive action and is addressed in this manner in the research effort.

Summary

The global economy is a fact and corporations in partnership with foreign governments use T^2 to structure innovation efforts and increase their competitive advantage (Sachs, 1998). USG recognition of this issue is found in the President's press release on technology where American economic growth is linked to technology advancement and international trade (Clinton & Gore, 1993). Military and/or dual-use T^2, as a subset of global T^2, may grow with Poland's scheduled admission to NATO in April 1999. This research centers on the exploration of the relationships of the participants in that process and the political and economic influences that are shaping the T^2 relationships between the USG, Lockheed-Martin and Boeing Corporations, the Polish government, and Polish firms.

II. Literature Review

Introduction

Economic competition has taken on a global perspective as firms extend their markets into other countries and continents. These international forays form strategic relationships to share technology in an effort to shorten product cycles and respond to changing market conditions. Dahlman (1989:13) sees these trends in technological development as the backbone for innovation in the product cycle. Technology transfer, as a fundamental process, couples scientific and technological assets for worldwide economic development. Much of the research in this area has focused on the commercial environment and has attempted to describe the dimensions of the T^2 process. These dimensions have been examined from many different perspectives in an effort to comprehend the various influences on the transfer process (Lee, 1994:260).

Simple T^2 Process

At the simplest level, the process of T^2 can be represented by the diagram in Figure 1. Once a technology is identified by the firm, the contents of that choice are transferred via some method to a recipient. The combination of content and method results in varying degrees of success as judged by the participants in the T^2 process. The participants will try to influence both the content and the method in order to mold the process in terms of their vision of success.

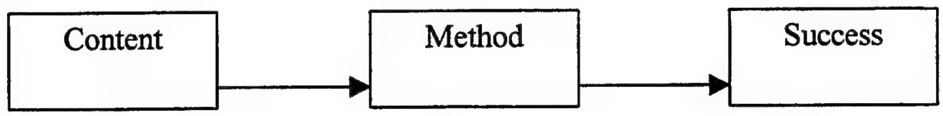

Figure 1. Simple T^2 Process Model

Content of T^2. Pirages states that T^2 can be either intentional or unintentional (1989:184). Intentional transfer occurs as a result of a conscious exchange process when participants legally accomplish the transfer through the market sale of the knowledge. From the viewpoint of the owner of the technology, unintentional transfer results from educational exchange, published research, scientific symposia, or industrial espionage by other firms. Others describe T^2 as either discretely disembodied (i.e., purely informational) or embodied "in the form of a product, machine, process, or person" (Mansfield, 1975) (Keller et al., 1990:34). The advantage of embodied technology rests in the ability of the recipient to immediately apply the technology. Disembodied technology must be slowly digested and infused into existing research.

The nature of T^2 can be further refined by breaking down the embodiment of technology into product-embodied, process-embodied, and people-embodied classifications (Hall & Johnson, 1970). Product-embodied technology is found in the physical product and can occur when exported products are reverse-engineered. Process-embodied technology resides in the technical data and patent rights associated with manufacturing processes. People-embodied technology rests in the evolution of an educated corps for support of the technology (Hall & Johnson, 1970).

A variant on the previous definitions includes three channels for the international transfer of technologies. Wang (1997:4) discusses the transfer of capital-embodied

(exports of equipment, tooling and intermediate goods), human-embodied (circulation through education, training, personal and professional contacts, etc.), and disembodied technologies (disseminated through patent literature, studies, operating instructions, etc). This is different than Pirages' notion of unintentional transfer in that in Wang's model, T^2 will only occur when the importer has control and can apply the technology.

Technology can also be categorized on a continuum between hard and soft technologies (Morgan, 1991). On one end of the continuum are hard technologies that are tangible. These technologies are well defined (i.e., extensive technical data and a history of application). Soft technologies are found in learned behaviors which cannot be distilled into systematized methods. An alternate classification scheme for T^2 divides soft technology or people-embodied technology into the training-related technology and "know-how" technologies that are embodied in organizational structures (Chiou et al., 1996). This refinement attempts to isolate the difference between learned responses through formal training and that information which is built into transferred organizational structures and inherited by the importer of T^2 without formal training.

Morgn's distinction of hard and soft technologies is important from two perspectives. First, people-embodied and some process-embodied technologies are "soft" in that they are less well defined and recognizable and thus are much more difficult to control by the supplying nation or firm. Second, product-embodied and other process-embodied technologies are "hard" in that they are well-defined, more tangible, and thus are more easily controlled. Subsequently, from a supplier viewpoint, many of the laws, procedures, and regulations created to protect technology are focussed on hard technologies.

The various researches have emphasized that the content of T^2 is a complicated construct, and have demonstrated that the distinctions are important to supplier/recipient transactions. However, researchers have not shown how content is influenced by the network of relationships in the T^2 process. There is a need to look for the commonality among the differing positions, and use the content construct in a larger context.

For the purpose of this paper, the T^2 content taxonomies presented by Chiou et al., (1996), Morgan (1991), and Wang (1997) can be incorporated into Hall & Johnson's (1970) description of product, process and people-embodied technologies. By Pirages' definitions, all three types of content (i.e., product, process, and people-embodied) T^2, can occur both intentionally and unintentionally. By Morgan's definition, the three types form the range of hand and soft technologies and with it the corresponding difficulties of control.

Methods of T^2. The method of transfer is the most apparent legal controller of the technology diffusion process. Thus, the literature on T^2 often concentrates on methods by which the transfer occurs. The choice of method in the international commercial environment can include any one of, or combination of the following cooperation transfer modes: wholly-owned foreign subsidiaries, joint ventures, foreign minority holdings, fade-out agreements, licensing, franchising, management contracts, turnkey ventures, contractual joint-ventures, international sub-contracting, and alliances (Buckley et al., 1997:5). Each of these modes of international cooperation includes varying degrees of transaction cost for the participants in the transfer process. Buckley et al., suggest that the key to cost-effective transfer hinges on keeping the transaction cost to a minimum. In the case of international T^2 the effects of differing political, economic, and legal systems

can dramatically affect the cost of the transaction and complicate the firm's decision on choice of mode for the transfer.

A Defense Department directive on international transfer of technology lists no less than twenty different means of T^2 while acknowledging that the primary modes are direct commercial purchases from firms and Foreign Military Sales which are subject to USG security assistance regulations (DISAM, 1997:493-494). An exhaustive explication of the modes of transfer for military and/or dual-use technologies is outside the scope of this thesis, and not necessary to the explanation of T^2 as it has occurred for U.S. defense firms and the Polish Government. Therefore, the research will be confined to descriptions of co-development/co-production agreements, licensing agreements, joint ventures, and foreign direct investment as the primary modes of T^2. Explanations of these modes will be presented from the standpoint of U.S. defense contractors seeking international contractual arrangements for defense items. However, it should be noted that these modes of T^2 may be used for civilian or commercial technology.

Co-development is defined as "a joint development project between the U.S. and foreign government(s) to satisfy a common requirement" (DISAM, 1997:698). Co-production is defined as either a USG-to-foreign government or U.S. commercial firm to foreign government contractual arrangement where the supplier agrees to develop or manufacture a defense item in the country seeking to purchase that item. These projects "may be limited to the assembly of a few end-items with a small input of local country parts, or may extend to a major manufacturing effort requiring the build-up of capital industries" (DISAM, 1997:464).

Licensing agreements result in contractual arrangements between U.S. commercial firms and foreign governments or foreign commercial firms to manufacture defense articles. The agreements usually include the licensing of technical data used in the manufacturing process. The USG is responsible for the approval of the export license request. "Such agreements generally establish quantitative limits on production, and prohibit third country transfers of the manufactured items" (DISAM, 1997:715).

Joint ventures are contractually established teaming arrangements between one or more U.S. firms and/or foreign firms to manufacture defense articles or provide services to foreign governments. These alliances can result in prime/subcontractor relationships. "The joint venture ... allows for the broadest possible transfers of technology - from product transfers, to the transfer of the equipment, the technical data, and the human know-how to make that product" (Westbrook et al., 1992:170).

Foreign direct investment is the process whereby U.S. firms choose to purchase existing foreign firms, merge with existing foreign firms, or build their own business facilities in a foreign country. These firms make capital investments directly in foreign economic systems in an effort to increase profitability. Foreign direct investment, while serving as a mode of T^2, has been a source of criticism. It is said to result in the loss of U.S. jobs, as production facilities are moved into less expensive labor markets (Lehne, 1993:66). In the case of foreign direct investment for weapons systems, job loss is not always pertinent.

Researchers have investigated the varying methods of T2 from the perspective of transaction costs, and by applicability to the actual content considered for transfer.

Researchers have not however, investigated how the relationships among participants in the T^2 process influence the methods of transfer.

<u>Success of T^2</u>. The success of the T^2 process is judged individually by each of the participants in the process. Each participant, as a member of an organization that wishes to succeed, will define a set of goals to insure this result. As each organization is different, the definition of success and goals to achieve that end will differ. By extension, the different strategies devised to reach the defined organizational goals will be accomplished based upon the capability of the organization to enact their chosen strategies. Organizational goals stem from organizational motivations to succeed. Exploration of the motivations of transferors and transferees is valuable for a clear understanding of the different participant perspectives. Kumar et al. (1996:36-40) created a taxonomy of T^2 motivations that does just that. The taxonomy presents a matrixed review of the differing economic, social, operational, strategic and personal motivations factors from the transferor/transferee perspectives found in the T^2 literature. The research reveals that by addressing the type of transfer (i.e., from industry to industry or country to country), the motivations and the perceived strength of those motivations differ for the participant. To understand how each participant views success, both the motivations and the strategies of the participant need to be addressed.

<u>Motivations</u>. Kumar suggests that receiving firms and governments are motivated to reduce cost, grow the economy, improve research and development capabilities, increase employment, elevate social or political status, advance society, improve access to new technology and know-how, increase productivity, and gain access to new markets. Supplying governments and firms are motivated to reduce cost, improve

profitability, increase employment, generate exports, increase sales, and increase sales of technology. It is not always the case that supplying nations and firms have similar motives. For example, the supplying firm's motive to transfer advanced technology may contradict the supplying government's motive for national security. Both supplying and receiving nations are motivated to increase tax revenues while the respective firms see this factor as a de-motivator. It is inevitable that differing participant motivations will lead to different perceptions of the meaning of successful T^2 and therefore different strategies to encourage T^2.

Strategies. In successful T^2 the bulk of considerations for import or export rest with the participants in the transfer process. The suppliers of technologies are focused on the strategic advantages afforded by the transfers. Recipients of the technology must focus on the strategic uses of the technology. Both participants must be sensitive to mutual needs for a successful transfer to occur.

Wagner (1993: 44) suggests that firms engaging in international business will use decision criteria including economic and political considerations at the firm level and at the country level to determine if the decision provides strategic advantages to the firm. However, care must be taken to consider the recipient's needs because the transferees' motivations for successful T^2 are different (Kumar et al., 1996:38-40; Chiou, 1996:19).

The supplier as possessor of technology will decide to transfer based on the perceived strategic advantages (Vickery, 1998) and will be motivated by a combination of economic, social and operational factors (Kumar et al., 1996:36-37). For recipients of technology the strategic use may be expected to foster increased profit as it drives innovation in products and increases competition in the host country. A clear

understanding of the types of technology available from multiple suppliers and the stage of the product life cycles will aid the recipient in making purchasing decisions that provide the greatest opportunity for profit. (Dahlman, 1989:15) As significant as adequate and timely information on technology is to the recipient, the movement of the acquired technology through various adaptations and improvements in answer to changing market conditions may be of greater importance. Without innovation, the technology will outlive its usefulness to the recipient. Those recipients who choose to import advanced technologies must have well-trained and educated support personnel to maintain the technology. In the case of soft or people-embodied technologies, the recipient must be prepared for the cultural and management differences that can be inherent in the importation of these technologies (Hofstede, 1992:81-94).

Influences on the T^2 Process

The organizations that participate in T^2 are not isolated. They exist in a complicated matrix of political, economic, financial, social and cultural influences. For the purpose of this research the focus will be on the political and economic aspects of the matrices that influence the USG, Lockheed-Martin and Boeing Corporations, the Polish government, and Polish firms. The following sections explore the supplier/recipient relationships in the commercial environment and the differences in these relationships when military and/or dual-use technologies are transferred and the barrier and bond activities that either encourage or inhibit the transfer.

Supplier/Recipient Relationships in the Commercial Environment. In reviewing the T^2 literature, a consistent theme of participant relationships involves the supplier and recipient of the technology (Buckley et al., 1997:2; Keller et al., 1990:34; Chiou et al., 1996:6; Dahlman, 1989:13; Lee, 1994:264; Vickery, 1998:6-14; and Wang, 1997:4). In each case, the research is focused on the commercial/civilian environment where the decisions to both transfer the technology and the choice of mode or method of transfer rest with the firm. The USG may track the export license, but the extensive review by the Departments of State and Defense does not exist. Regardless, the nature of the relationships in the literature is basically dyadic.

In the transfer of military and/or dual-use technology, the responsibilities are different. Firms that import military and/or dual-use technology in conjunction with their governments must also contend with any supplying nation to receiving nation government-to-government agreements for the protection of the technologies that may be classified (DISAM, 1997:499). The importer of military and/or dual-use technology in the recipient role must contend with its government's oversight of that technology. Thus, neither the supplier nor recipient are divorced from their respective governments' involvement in the supervision of the military and/or dual-use T^2. This fact alone supports the existence of supplying nation to receiving nation, supplying nation to supplying firm, and receiving nation to receiving firm relationships.

In the transfer of military and/or dual-use technologies, the dyadic supplier/ recipient relationship fails to provide a complete picture of the complex bonding activities that transpire between the supplying nation and supplying firm or between the supplying nation and receiving nation.

In the second half of the 20^{th} century, the USG has had a strong national economy that, expressed in terms of gross domestic product, has progressively increased through 1998. The global economy offers business opportunity while threatening to undermine the U.S. labor market as corporations take manufacturing jobs to cheaper markets. To maintain the stability of the industrial base, the USG wants its corporations to effectively compete in the global economy, but not at the risk of losing technologies to counties unfriendly to worldwide democratic stability.

Before 1980 and the explosion of the global economy, the profitability of Lockheed-Martin and Boeing Corporations' military aircraft divisions was intimately tied to the political and economic considerations of the USG. The creation of NATO in 1948 brought them opportunities for foreign military sales and these corporations provided military and/or dual use technologies that helped to rehabilitate the industrial base of Europe. In today's market, they are competing with those rehabilitated industries in an environment that is increasingly competitive and less responsive to the influences of the USG. Now they must compete globally and their profitability can be tied to the economic and political indicators of any buying nation.

By 1989, Poland, a member of the Warsaw Pact, had been crippled economically through Soviet central planning. In that year, Poland was thrust into an environment where lack of recent experience in democratic rule and the dramatic fluctuations of a new market economy helped to create inflation rates of 600% (Howell, 1997:504). To revitalize their industries and stabilize the continuing evolution of a representative democracy, Poland looks to the world for the importation of capital investment and technology.

Barriers and Bonds. The political and economic environments of the USG, Lockheed-Martin and Boeing Corporations, and the Poland are different and exert contrasting and sometimes conflicting influences on the participants to the international T^2 process by inhibiting or encouraging chosen strategies of those participants. The complex interaction of activities for successful international T^2 can be grouped into categories of barriers and bonds (Keller et al., 1990). Barriers are those activities that constrain international transfer of technology. Barriers include the political, economic, legal, social, and cultural considerations that influence decision-makers to institute protectionist T^2 policies. Alternately, bonds include activities that facilitate the transfer and comprise both intra-firm and inter-firm strategies. A pictorial representation of the relationships can be found in Figure 2.

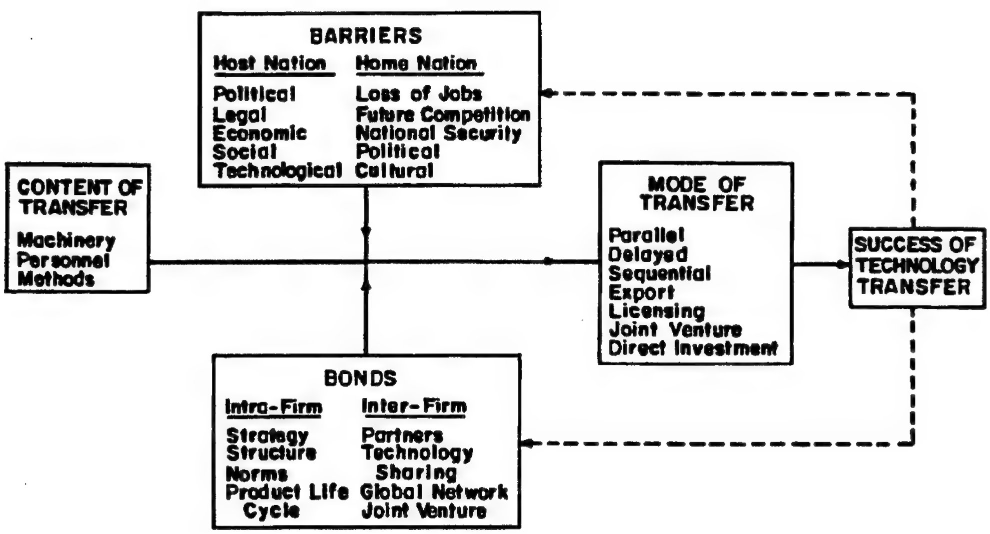

Figure 2. Model for International T^2 (Keller et al., 1990:35)

By inhibiting or encouraging international T^2, barriers and bonds affect the success of the transfer. The strength of the model lies in its recognition and integration of barrier and bond activities into structured framework of successful international T^2. However, the model characterizes the barriers as concentrated within the purview of nations activities and bonds as being firm-related actions. Additionally, the Keller research provides only anecdotal evidence of the barrier/bond activities without discussion of any interactive influences between host and home nations or between the firms and host and home nations.

The model suggests that intra-firm activities, actions within the individual firms, and inter-firm activities, actions between different firms, are the source of bonds. This type of bond isolation falls short of depicting the bonding activities that can transpire in home (supplying) and host (receiving) nations. Similarly, the barrier isolation fails to illustrate the barrier-creating actions that can transpire in and between international firms. Given the historically complex nature of T^2, both barrier and bond activities are found in and among all the participating nations and firms.

In addition, the intra-firm and intra-nation activities create the motives these participants bring to their inter-firm/nation relationships. Within firms or nations, there is often conflict and contradiction. The resolutions to the conflicts and contradictions affect the strategies chosen for the inter-firm/nation relationships.

An Integrative Model for International T^2

An improved model that better describes the nature of international T^2 between these organizations may be found in Figure 3. The revised model includes a listing of

relationships in bonds that represent differing goals/strategies or agreement structures and influence the content and mode of T^2. Similarly, the model includes these same relationships in the barriers and these relationships serve to constrain the options available to content and modes of international T^2. Each participant (i.e., supplying/receiving nation/firm) is influenced by important intra-nation/intra-firm considerations. Essentially, the bonds create possibilities for content and mode while the barriers limit those possibilities based on the economic and political relationships and goals of the participants. Kumar et al.'s (1996:36-40) taxonomy provides evidence that perceived differences in motivations/goals of these participants do exist and are measurable in the T^2 literature.

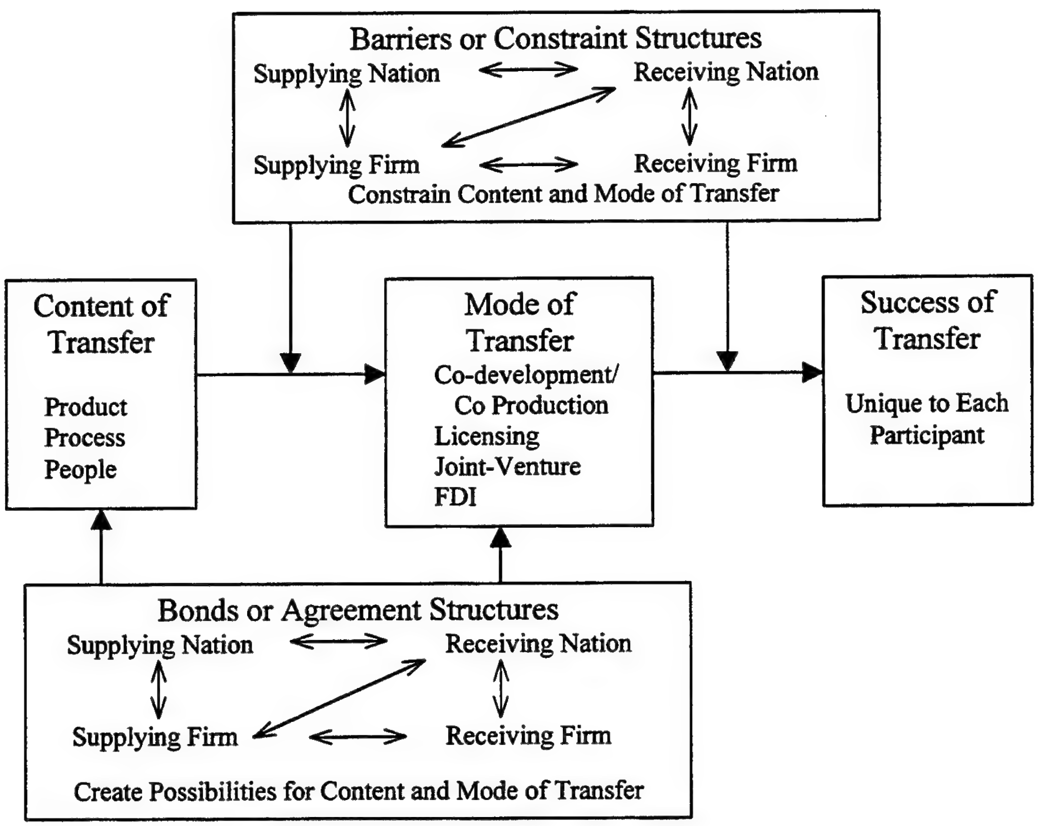

Figure 3. Revised Model for International T^2

An exploration of the intra/inter organization activities provides insight into the barrier or bonding action that inhibit or encourage the transfer of military and/or dual-use technologies.

Intra-Organization Relationships. USG barrier activity can be examined through the intra-governmental relationships in the T^2 process. In the case of military and/or dual-use technology, the supplying firm does not possess complete control over the process of exporting or transferring technologies. In an effort to provide national security, the USG maintains the rights to approve requests for export licenses for the transfer of these technologies. The process is complicated and no single governmental entity makes the decision.

> The export control process can involve cabinet departments (State, Defense, Energy, Commerce, and Treasury); the Joint Staff; the National Security Council; National Economic Council; the President; several interagency working group; three interagency escalation groups; three different intelligence agencies, two independent agencies; and at least three enforcement agencies. (DISAM, 1997:503)

As the licensing process has evolved, a series of laws and lists determine those defense items and technologies, which come under the control of the USG. The Defense Department coordinates on the decision to release listed items or technologies. These list and laws reflect identified security measures put in place by U.S. and international militaries and governments. In the U.S., the Departments of Commerce, Energy, and State have separate areas of responsibility. The Energy Departments scope of responsibility rests in the protection of nuclear and nuclear dual-use technology in the domestic and international environments. The Commerce Department monitors domestic

and international use of commercial and other dual-use technologies. The State Department must contend with international agreements for the control of munitions and missile technology. The sophistication of U.S. military weapons systems puts the Defense Department in the role of coordinating in all areas of responsibility that affect military-critical technology. A complete, although elementary, diagram of the participants, lists, and laws can be found in Figure 4.

A particular type of technology may end up on several lists and be subject to a myriad of different and sometimes conflicting laws, regulations, international agreements, and procedural reviews. However, there is a process in place which provides the transparency needed by all interested departments and groups to accomplish the network of interacting reviews and coordinations. This process is depicted in Figure 5.

As the purpose of this research is not an exhaustive illustration of the licensing process, a simplified explanation must suffice. The USG, in accordance with the Arms Export Control Act and the multi-lateral controls in the Wassenaar Arrangement of Export Controls for Conventional Arms and Dual-Use Goods and Technologies, controls the licensing process. The Commerce Department maintains the approval authority for dual-use technology export licenses with reviews, recommendations, and co-ordinations by the State Department and the Defense Department. The State Department retains the approval authority for munitions or military technology export licenses with reviews, recommendations, and coordinations by the Departments of Commerce and Defense.

In the case of certain types of commercial arrangements, the USG under the auspices of the International Traffic in Arms Regulation must also provide approval of the transaction. "These [commercial arrangements] differ from regular export licenses in

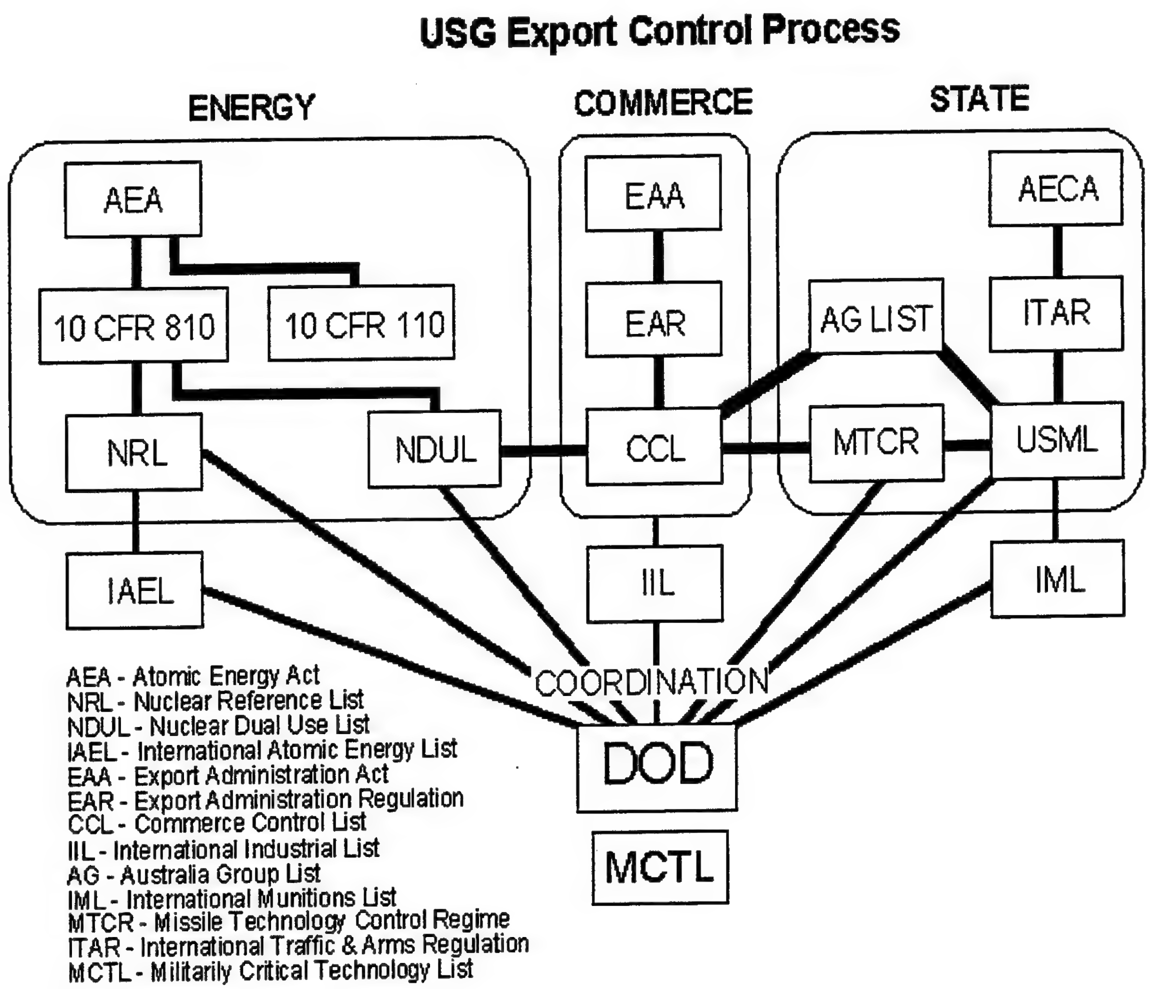

Figure 4. USG Export Control Process (DISAM, 1997:504)

that they are broader in scope, more flexible, and remain in effect for longer periods of time. They are typically for ongoing projects rather than one-time exports (DISAM, 1997:507)" and include technical assistance agreements, manufacturing licensing agreements, and distribution agreements. Firms requesting licenses may be driven by a profit motive, but the lack of total control over the final approval to transfer the technology and in some cases the mode of transfer indicates that the motives behind the

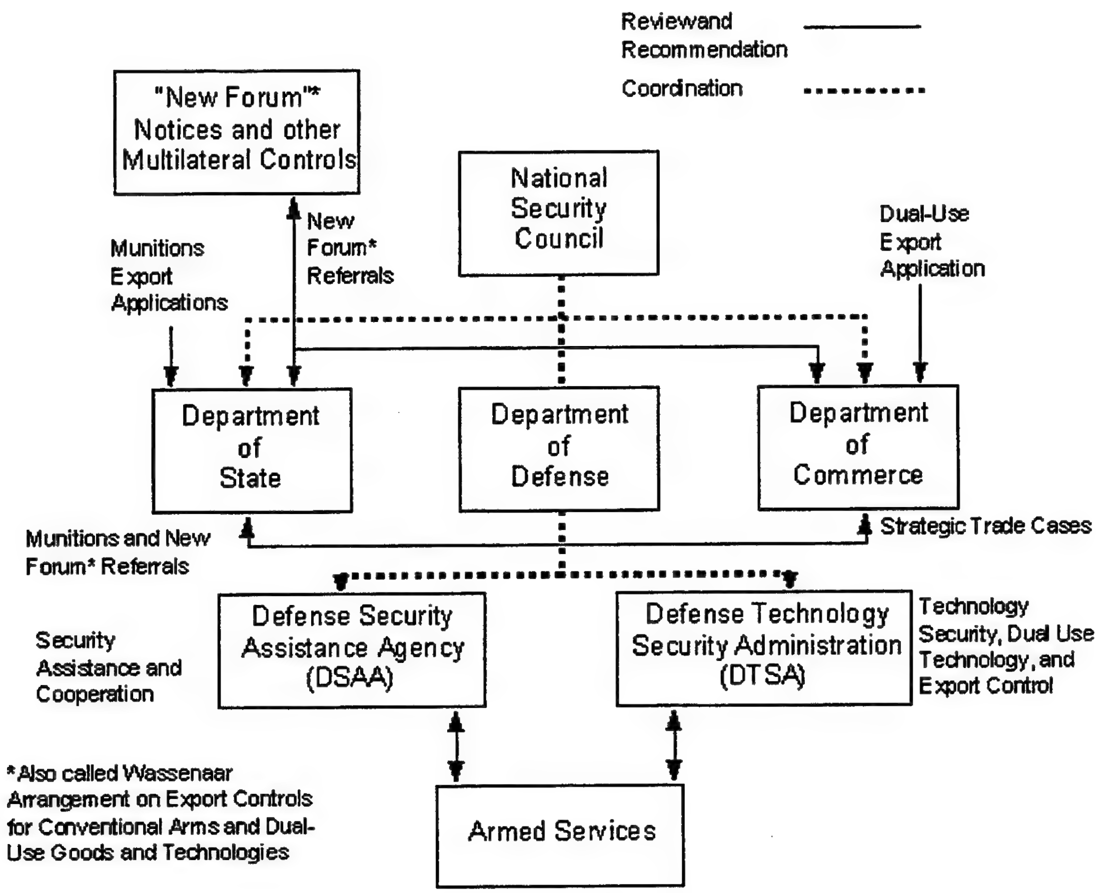

Figure 5. Technology Security Overview Process (DISAM, 1997:490)

USG approval are different than the firm motives. It is safe to assume that those approvals also provide strategic national security advantages to the USG (DISAM, 1997:489).

The nature of the USG approval process illustrates the potential conflict present in the process. Subordinate groups in the USG influence approval decisions for content and mode of transfer and the influences often come from conflicting motivations and strategies.

Inter-Organization Relationships. Support for the revised model is present in an exploration of the USG barrier/bond actions as they relate to either encouraging or inhibiting international T^2 between Lockheed-Martin and Boeing Corporations, the Polish government, and Polish firms. The eventual creation of the NATO alliance relationship between the USG and Poland will provide Poland and its firms increased access to military and/or dual-use technologies from Lockheed-Martin and Boeing Corporations. The supplier nation to receiving nation relationship will provide a bond that enables supplying firms to provide content and creates opportunities for the mode international T^2.

Actions. The revised model can be used to explain the strategies chosen and actions taken by each participant in the context of their relationships with each other. Lee (1994:260) identifies six descriptive actions that enumerate specific behaviors recognized as contributing to successful international transfer. These actions are presented in Table 1.

By framing T^2 actions in series of explicit activities, Lee provides operational definitions that can be used in the methodology for further research. These functions can provide a framework for evaluating the actions taken by each participant in T^2 process. These actions can further be defined by the cross-function overlaps in the political, economic, financial, social, and cultural influences that affect the T^2 process.

Table 1. Actions Encouraging Successful T^2 (Lee, 1994:261)

	Action
1)	Upgrade scientific and technological infrastructure (education, training, equipment, facilities, institutions)
2)	Deal with the funding gap, that is financing pre-commercialization research (a vacuum existing between fundamental research and industrial research)
3)	Convert dual-use military technologies into civilian industrial innovation, and inevitable post-Cold War adjustment
4)	Reform laws, bureaucratic rules, procedures, organizational cultures, and personalities that interfere unreasonably with transfer processes
5)	Create and empowering partnerships between technology suppliers and technology recipients
6)	Deal with the global trading environment that impedes technological competitiveness

Summary

Although the contents (i.e., product, process, and people embodied technologies) and modes of T^2 can be similar for commercial and military and/or dual-use technologies, the actual number of methods utilized is somewhat less. The modes have been limited to the critical subset of methods that are important to the context of T^2 from U.S. firms to the Polish government and Polish firms. These include co-development and co-production, licensing, joint ventures, and foreign direct investment. The possible

contents and modes of T^2 are also constrained by the bond and barrier activities of the participants in the transfer process.

The traditional supplier/recipient models for commercial T^2, represented by the Keller model does not provide a complete picture of the complex intra-organizations relationships for participants in the transfer of military and/or dual-use technologies. The intra-organization relationships determine the motives of the participants and provide the context for the strategies chosen and action taken.

Similarly, the Keller model fails to recognize that barrier and bond activities occur at both the firm and nation level. Bonds are not only formed between firms, as Keller (1990) as suggested, nor are barriers formed only between nations. Both bonds and barriers form through the relationships between supplier and receiver nations; and supplier nations and their respective firms; receiving nations and their firms; and supplier firms and receiving nations. The revised model for international T^2 of military and/or dual-use technology includes these important inter-organizational relationships, and explains how bonds and barriers influence the content and mode of the process.

Based on this framework of content, modes, barriers and bonds, Lee's (1994) activities can then be used to describe the strategies taken by participants in the context of their relationships with other participants.

The test for any new theory is whether the data fit the new or revised model better than traditional models. The next chapter discusses the methodology that will be used to collect and analyze the available data. Chapter four will present a story of T^2 in terms of the strategies developed and used by the USG, Lockheed-Martin and Boeing Corporations, the Polish government, and its firms. Their actions will be explored in the

context of their relationships and desire to reduce barriers and increase bonds in an attempt to meet their own visions of success.

III. Research Methodology

This research is designed as a qualitative case study and comparative analysis. A case study methodology was utilized to describe the complex interactions and motives of the participants in the transfer of military and/or dual-use technologies to Poland. This offered the researcher an opportunity to view the complex topic of supplier/recipient relationships in the scoped environment of a single country. The complex interactions and motives of these participants were be analyzed in the framework of the revised T^2 model and the six activities that participant's used to achieve their T^2 objectives. The revised model is an extension of Keller's (1990:35) model, and an expansion of the traditional dyadic views of supplier/recipient relationships. A comparative analysis took place by examining the strength of the explanation provided through the revised model that would not have been addressed by the traditional approaches.

Data Sources

Secondary and archival sources of data in the form of books, newspaper articles, journal articles, speeches, manuals, and congressional testimony relating to the current activities of T^2 participant strategies were be collected and analyzed in an effort to discover and interpret the influences which drove changes to those strategies. In this way "the researcher looks for constructs that bring order to the descriptive data and that relate these data to other research findings reported in the literature" (Gall et al., 1996:549). These procedures were implemented in an effort to discern and interpret patterns of activities that contributed to the revised model for successful T^2.

Data Analysis

The political and economic phenomena that relate to the concept of the global economy were collected and interpreted in an effort to ascertain their effects on the activities of the participants. "Interpretational analysis is the process of examining case study data closely in order to find constructs, themes, and patterns that can be used to describe and explain the phenomena being studied" (Gall, 1996:562). It was assumed that the political and economic pressures associated with increased globalization were inferred from the collected data and that the analysis of the rich detail lent itself to the proposed interpretational analysis.

The theoretical content of T^2 is well established in the literature (Chiou et al., 1996; Hall & Johnson, 1970; Keller et al.,1990; Mansfield, 1975; Morgan, 1991; Pirages,1989; and Wang, 1997). In addition, Kumar (1996) has presented empirical evidence that supports a taxonomy of contrasting motivations by participants to the transfer process. The existence of these differing perspectives on T^2 challenge the traditional nature of supplier/recipient (i.e., supplying firm to receiving firm) models in the complex relational environment of military and/or dual-use T^2. A comparative analysis was used to highlight those relationships among the participants in the transfer process that are not addressed in the traditional model in order to determine if the proposed revised model provided a more complete picture of their interactions.

With an understanding of the political and economic influences that shape participant technology goals, the researcher began the process of investigating the effects

of these goals on the participant strategies in the transfer of military and/or dual-use technologies to the country of Poland.

Participant activities were analyzed in the context of Lee's (1994) six strategies in an effort to determine whether they are engaged in specific behaviors recognized as contributing to successful transfer. The specific behaviors are aimed at increasing bonds or decreasing the effects of barriers. Traditional supplier/recipient models would look at the dyadic relationship between the supplier of the technology and direct recipient. For commercial T^2, this would likely be the relationship between two firms. According to the revised model for the transfer of military and/or dual-use technology the relationship of interest may be any one or combination of the following relationships: supplier nation to receiving nation; supplier nation to supplying firm; supplying firm to receiving nation; supplying firm to receiving firm; and receiving nation to receiving firm.

The purpose of this paper is to show that the traditional supplier/recipient model ignores critical relationships that influence the content, mode, and success of T^2.

<u>Summary</u>

This case study is an exploratory, qualitative investigation for the purpose of gaining insight, meaning, and interpretation of military and/or dual-use T^2 as it emerges from the evolving perspectives of the participants in the transfer process. A comparative analysis is used to determine the validity of the revised model for international T^2. With this methodology in hand, the next chapter investigates the T^2 activities of the USG , Lockheed-Martin and Boeing Corporations, the Polish government, and Polish firms. The archival and secondary source literature was investigated in an effort to determine

the extent to which these participants in the transfer of military and/or dual-use technologies engaged in the activities contributing to successful T^2. These activities were further described in the context of whether they were aimed at reducing barriers or increasing bonds in accordance with the framework provided by revised T^2 model. A matrixed summary of the results is presented at the end of the chapter.

IV. Results and Analysis

This chapter tells a story of strategies and actions by nations and firms intent on meeting their respective objectives in a span of years between 1989 and 1998. The general thesis of the research effort is that this story would be inadequate if the framework relied on traditional supplier/recipient models. Accordingly, it will be told based on an expanded and integrated model that considers the network of relationships of supplying and receiving nations and firms as they enact strategies in concert (bonds) and in contradiction (barriers) to achieve their respective motives.

The story will be related as though the nations and firms are homogeneous. This underlying assumption is at the same time both absurd and rational. No entity as large as a nation or firm exists in complete harmony. Conflict and contradiction are inherent at the intra-nation and intra-firm level. Yet contradictions within nations or firms have ways of resolving themselves and create the context in which each participant nation or firm views success in the process of T^2.

The narrative will begin with a brief discussion of the political and economic intra-nation and intra-firm considerations that shape the goals of each participant in the T^2 process. This discussion will then provide the context for the motives of the USG, U.S. defense firms, and the Polish government as the story of interacting strategies and relationships is reported.

Intra-Nation/Firm Political and Economic Context

USG. At the end of World War II, the U.S. economy and infrastructure were intact. U.S. science and technology had provided effective tools to the warfighter, and the choice to share that technology was largely governed by the U.S. desire to have strong and active democracies in Western Europe in an attempt to establish and maintain a global defense. The Cold War brought about the arming of European NATO member militaries in the period from 1950 to the late 1970's. This situation mandated the transfer of U.S. military and/or dual-use technologies to the rehabilitated European manufacturing base (Bluestone et al., 1981: 84-85). The protection of these technologies fell into the purview of national security. The Defense Department's directive describing international transfer of technology defines the department's two-fold T^2 responsibility.

> It shall be DOD policy to treat defense-related technology as a valuable, limited national security resource, to be husbanded and invested in pursuit of national security objectives. Consistent with this policy and in recognition of the importance of international trade to a strong U.S. defense industrial base, the Department of Defense shall apply export controls in a way that minimally interferes with the conduct of legitimate trade and scientific endeavor. (DISAM, 1997:489)

Over the past ten years, the strength of the military industrial base has become increasingly dependent upon foreign sales. Figure 6 depicts the shrinking U.S. investment in defense as a percentage of federal outlays. During this period, the USG as reduced defense spending in response to growing concerns for domestic investment. Those monies previously earmarked for defense were transferred to support internal domestic needs. With less U.S. defense investment, the military aircraft industry has contracted and merged to remain competitive and ensure survival. The industry has also

turned its attention to global markets. This places the USG with an escalating problem of controlling the transfer of its own military technologies.

Year	Defense Outlays as Percent of: Federal Outlays	Defense Outlays as Percent of: Fiscal Year GDP
1988	27.3	6
1989	26.6	5.9
1990	23.9	5.5
1991	20.7	4.8
1992	21.6	5
1993	20.7	4.7
1994	19.3	4.2
1995	17.9	3.9
1996	16.9	3.6

Figure 6. National Defense Outlays (U.S. OMB, 1998:3)

The need to protect critical technologies has come to conflict with the need to export those same technologies. The line between dual-use and commercial technologies has blurred and the USG has become increasingly concerned about the eventual users and uses of all U.S. technologies. This concern is vested in the complicated network of overlapping reviews and coordinations required for approval of export licenses (refer back to Figure 4). To maintain a strong industrial base the USG has encouraged the sale and transfer of U.S. military and/or dual technologies (see Appendix A). The approval to release those technologies in an increasingly globalized environment has escalated the risk of those technologies coming into the hands of unfriendly nations.

The USG is under increasing pressure from corporations to reduce the number of technologies requiring dual-use export licenses. The USG requires dual-use export licenses for some classes of precision industrial tooling. European industries regularly export the same tooling with little regard for its military application. The USG decision to constrain the transfer of technologies reduces U.S. corporate competitiveness in the global economy and puts our industrial base at risk.

However, the dramatic changes in Eastern Europe since 1989 have caused international concerns in the transparency of decisions to approve the transfer of certain types of technology. Former security initiatives were replaced by the Wassenaar Arrangement. U.S. firms exerted pressure on the USG to avoid unilateral trade embargoes on U.S. technologies that were routinely transferred by other nations because the U.S. Export Administration Regulation (EAR) was not in line with the Wassenaar Arrangement.

The Wassenaar Arrangement was a united international effort to expand technology information exchange and reduce the conflicting international technology policies. On January 15, 1998, the U.S. Department of Commerce published extensive changes to the U.S. Export Administration Regulation to bring U.S. oversight and procedures in line with this arrangement (U.S. Dept. of Commerce, Bureau of Export Administration 1998:1). The international political nature of the Wassenaar Arrangement in conjunction with the pressure exerted by U.S. firms shapes U.S. national technology export policy and regulation.

In spite of this agreement, some congressional constituencies have pressed for additional controls on the export of military technologies. They posit that the sale of

arms to other nations creates an answering need for the USG technologies to increase their level of sophistication. For example, if Lockheed-Martin sells the F-16 to foreign nations, the then USG must purchase the F-22 to stay ahead. Defense contractors stand to profit from both USG and foreign government purchases. "The net result of this logic would be an arms race ... in which the U.S. arms industry would in essence be supplying both sides of the conflict: an arms merchant's dream but a nightmare for U.S. security" (Hartung, 1994:163). These concerns conflict with strategies of U.S. defense firms who see foreign sales as a method for maintaining jobs for defense workers and increasing profits. National economic changes and conflicting political agendas have influenced the development of the USG technology policy and put national security stability and economic stability in increasing conflict.

U.S. Defense Firms. At the end of World War II, the corporations that supported the USG war effort experienced a severe contraction as military manufacturing plants were converted to commercial operations. The remaining plants dedicated to military manufacturing were located on opposite coasts. The airframe business centered on the west coast and the "aircraft engine and propeller manufacture" was located on the eastern seaboard (Bluestone et al, 1981:33). Over the years between 1950 and present, Lockheed-Martin and Boeing Corporations have expanded and contracted regularly with fluctuating government requirements (Todd et al, 1986:36-37). During this period, Boeing may have suffered less given that they invested heavily in the commercial side of the aircraft industry.

Both corporations had opportunity with the founding of NATO to engage in international T^2 in the European industry rehabilitation. American management and

manufacturing methods were used as the baseline for revitalization of the industrial bases of Europe and Japan. Agreement to procure U.S. weapons systems were usually conditioned upon co-development and co-production, license, and transfer of technology as an offset to the purchase. As these economies gained strength through various direct and indirect offset arrangements, U.S. corporations saw the rise of a new set of competitors. From the late 1980's to the present, U.S. corporations faced dwindling U.S. defense budgets and have merged in ever increasing numbers. From 1990 to the present, Boeing purchased McDonnell Douglas, Rockwell International, Litton Precision Gear, and United Technology Laboratories. In the same period, Lockheed purchased Loral and merged with Martin Marietta. These mergers were activities that placed the participants in improved competitive positions both domestically and internationally by producing economies of scale.

From a political and economic perspective, Lockheed-Martin and Boeing Corporations can meet the USG strategic need for placement of military and/or dual-use technologies in Poland. Given the need for Poland to meet NATO interoperability conditions, these corporations can also meet Poland's specific technical assistance requirements. The growing international competition for lucrative foreign military sales contracts means that USG and U.S. corporations will need to offer significant offset arrangements to Poland. Unfortunately, the tradeoff for an industrial offset may be the emergence of another competitor in the world market and world demand is not likely to support another aircraft industry entrant. The effects of a shrinking domestic military investment is seen to force U.S. defense contractors to merge with one another and

propose foreign offset arrangements in an effort to maintain a competitive advantage in the global economy.

Poland. At the end of WWII, the Polish industrial base had been destroyed. The Soviet Union recognized the importance of a strong Polish industry and through capital investment and central planning re-established the key heavy industries required to support their Cold War efforts. Industrial workers, through the actions of the trade union, Solidarity, would eventually lead the fight to reestablish democracy in Poland. "With the dissolution of [Communist] identities, values, and institutions in 1989 the power of the image of the West increased, signifying both a saving anchor and the promised land (Wydra, 1997:28)". Since 1989, the efforts of the USG and Western Europe have focused on support for Polish democratic and market reforms at national, state, and local levels. The initial economic downturns in Poland devastated personal earning power and support for the necessary reforms. The reform measures included "radical reforms …to free prices, reduce the government deficit, inflation, and trade restriction, increase privatization to improve foreign investment, and restructure the banking system" (Howell, 1997:504). However, Poland has emerged as a fast growing economy with a GDP increase of 6-7% in 1996 (U.S. Dept. of State, 1997:1).

Early on, the Polish nation displayed a simultaneous interest in membership in NATO and the EU. NATO membership represented a desire for political security. To join NATO, the Polish defense forces must reach interoperability with member nation militaries. The costs associated with the required military infrastructure transformation vary widely, but certainly conflict with the economic demands of the commercial and civilian sectors. Poland also desires the economic stability and power associated with

membership in the EU. To gain EU membership, Poland will need "financial aid to modernizes its large but inefficient farming and food industries…and for restructuring rural areas and infrastructure during the [EU] pre-accession period" (Embassy of Poland, April 1998). Poland's monetary resources provide scant support for its competing membership in both NATO and the EU when compared with the desperately needed investment in domestic communications and transportation infrastructure.

Technology transfer is critical for efficient conversion of the political and economic systems. Much of the on-going change has centered on activities that will encourage foreign direct investment. To nourish foreign direct investment, the Polish government has offered tax incentives to foreign capital investment firms. These incentives cause conflict with newly privatized Polish companies who do not always enjoy the same incentives. With looming increases in the Polish international trade deficit, desire for domestic protectionist trade policies have increased.

Even as Lockheed-Martin offers the F-16 and Boeing proposes the F-15, Poland must contend with the pressure from the EU to purchase a European product. The EU products include the Saab-Bae JAS 39 *Gripen* and the Dassault *Mirage* 2000-5. Most EU members are also members of NATO and the conflicts between the USG and other NATO members could threaten the stability of the alliance (Tigner, 1997a:1). Should Poland decide to purchase fighters for the Polish Air Force, its decision affects the viability of Polish firms as each offer may extend differing offset opportunities. This combinations of internal and external factors will force Poland to carefully weigh its military needs in light of domestic and EU influences.

Inter-Nation/Firm Actions in the Political and Economic Context

The strategies taken by the USG (supplying nation), Lockheed-Martin and Boeing Corporations (supplying firms), the Polish government (receiving nation), and Polish firms (receiving firm) can be categorized according to the six actions recommended by Lee (1994) that encourage successful T^2. Data collected from 1989 to the present represent those activities may have had an impact on T^2 to Poland since the end of the Cold War. Six sections follow one for each of Lee's strategies. Within each section, the actions of the various participants are explained in the context of the revised T^2 model. Activities are defined as being either a barrier or bond and are described in the context of whether they influence the content or mode of T^2.

Action 1) Upgrading Scientific and Technological Infrastructure. Improvements to the scientific and technological infrastructure are critical to the success of T^2. Without adequate facilities and properly trained scientists and technicians in the employment pipeline, technology use will stagnate and little innovation can occur. Upgrades to the scientific and technological infrastructure have been initiated by the U.S. and Polish governments as well as U.S. firms. The recipients of these initiations have been all three of these participants as well as Polish firms. The following vignettes describe supplying nation to receiving nation, supplying firm to receiving nation, and receiving nation to receiving firm relationships in the revised T^2 model.

Supplying Nation/Receiving Nation. The USG efforts in this arena are accounted for with the authorization and obligation of monies under a variety of international programs aimed at supporting the democratization and market economy of Poland. A USG estimate of total aid from the United States to Poland (Department of

State, 1997:2) amounts to $90.4 million in 1995, $66 million in 1996, and $52.7 million in 1997. This aid has directly or indirectly helped in the transfer of technology and has been provided in the Support Eastern European Democracy Act, Foreign Military Financing funding, and International Military Education and Training funding.

The Support Eastern European Democracy (SEED) Act of 1989 provided $40.1 million in 1997 and an estimated $35 million in 1998. Although not directly tied to the Polish military, the monies were used to aid the passage of "nine laws which improved the framework in which businesses operate" (USAID, 1998:1-5). The monies were used for economic restructuring, the democratic transition of local governments, and other cross-functional special initiatives. By providing the funding the USG is encouraging the transformation and the successful growth of the private sector market which will lead to an improved environment for T^2.

Foreign Military Financing (FMF) requested under the Partnership for Peace (PFP) in 1996 for this program, was $18.5 million (Department of State, 1996:346). An example of its use is the U.S. Air Force technical study to aid Poland " [to] upgrade and standardize their civil-military airspace management systems" in an effort to re-equip "six [Polish]...airbases now in use to meet NATO standards" (Tigner, 1998:18). In 1996 President Clinton recognized the importance of support for Poland's entrance into NATO and dubbed his effort the "Warsaw Initiative" (Department of State, 1996:343). The funding eventually provided support for the technological infrastructure.

International Military Education and Training (IMET) funding was used to "train Polish defense officials at U.S. facilities in areas such as defense planning, military doctrine, and peacekeeping in order to improve Poland's understanding of U.S. practices

and to expand co-operation between ... militaries" (Department of State 1996:347). The information passed to the Polish military through this program supports the education of the military infrastructure and contributes to an upgrade of the military.

The USG funding for Poland represents a supplying nation to receiving nation relationship. It constitutes efforts to increase bonds between these countries that foster an environment, which encourages successful T^2. Monies used to address reforms to a market economy, rebuild needed infrastructure, and aid in the democratization of local governments are seen to beneficially affect the modes of transfer. These activities also allow U.S. and Polish firms to exploit the advantages of the emerging market economies in Poland (supplying nation/supplying firm and receiving nation/receiving firm). Similarly, the aid to education and training help to create an educated core of individuals who support advancement of technologies and thus affect the product content of the transfer. The reforms benefited the receiving nation by allowing fuller exploitation of the technology for innovation and may result in increases to tax revenue. The supplying firm will recognize cost savings and economic growth and gain profit. The supplying nation will see improvement in its industries' ability to compete globally.

Supplying Firm/Receiving Nation. Since 1993, Boeing Corporation has also taken action to upgrade the Polish scientific and technological infrastructure by sponsoring physics researchers from Poland at the University of Iowa.

> This is the third joint Polish-U.S. scholarship program undertaken by Boeing this year. This summer, before merging with Boeing, McDonnell Douglas sponsored seven Polish law students in a special Polish-American graduate seminar at Jagellonian University in Krakow, and this fall Boeing will sponsor Polish graduate students who are pursuing studies in scientific and technical areas at American colleges or universities. (Boeing, 1996)

These corporate investments are seen to create bonds with the receiving nation that will beneficially affect both the content and mode of T^2 to Poland. By investing in legal education, Boeing fosters an atmosphere where U.S. business interests can flourish and reduce the barriers associated with differing systems of law. The exposure of Polish lawyers and scientists to the U.S. culture through educational exchange can be interpreted as an opportunity to reduce the cross-cultural barriers through educational exchange. The modes of T^2 agreements are protected by law (i.e., licensing, joint-ventures, etc.) and Boeing's activities can be seen to beneficially affect the mode of transfer and answer their motivation for more equitable trade agreements. By investing in scientific and legal education they are affecting people-embodied aspect of the content and these activites can increase the sales of their technology. For the receiving nations Boeing's actions improve the quality of life and improve their access to new technology as corporations seek better business agreements and technical support for their products.

Receiving Nation/Receiving Firm. Poland's initiatives for upgrading scientific and technological infrastructure are concentrated in the Foundation for Polish Sciences, "an independent, self-financing, non-profit institution which was officially founded in 1991 to support the development of science in Poland" (USAID Report, 1997:A-23). The foundation was given a one-time endowment of $100 million by the Polish government. This institution, in consultation with an extensive network of institutions of higher education, are providing training and loans in an effort to invest in the commercialization of applied scientific research.

> A natural evolution of economic growth has been a heightened interest in applied science, and this has taken shape in the articulated belief ... that Poland is ready to host technology parks and special research and technology transfer centers, ...but the essential point is that several academic institutions are beginning to work with commercial interests and to pursue industrial innovations. (USAID Report, 1997:A:19)

Poland 's investments and the scientific communities' support for commercial transfer centers are representative of receiving nation to receiving firm relationships and are seen to provide a positive bonding action that will affect the content of the technology transferred. These strategies are an answer to Poland's motivation for increased access to research and development and its application to the commercial environment in hopes of enhancing economic development

Synopsis. The described actions are examples of activities which Lee (1994) suggests will encourage successful transfer of technology. These participants in T^2 are motivated to achieve strategic goals that will insure their economic and political survival by providing increased support for the scientific and technical infrastructure. The relationships (i.e., supplying nation/receiving nation, supplying firm/receiving nation, and receiving nation/receiving firm) which are targeted at improving bonds to facilitate content and mode of T^2, are not accounted for in the traditional supplier/recipient model.

Action 2) Dealing with the Funding Gap for Pre-commercial Research. Scientific research has always been the cornerstone for advances and innovation in the commercial environment. As new ideas and application made it out of the lab and into the product life cycle, new product innovations spurred the buying public to purchase. Investment in the research requires a long-term vision because the investment may not result in a new

product or may take many years to make that transition. It is critical to maintain the funding for pre-commercial research or the opportunity for transfer of the resulting technologies will never occur. Data collection resulted in examples of the supplying nation to supplying firm, supplying firm to receiving nation, and receiving nation to receiving firm relationships. Participants in these relationships engaged in the funding of pre-commercial research. The term "engaged" will have multiple meanings depending upon the relationship and need. In some cases it will mean an action, in others inaction or reduced action.

Supplying Nation/Supplying Firm. The USG was the primary investor in pre-commercial research from 1945 to 1980. The peak of their investments occurred in

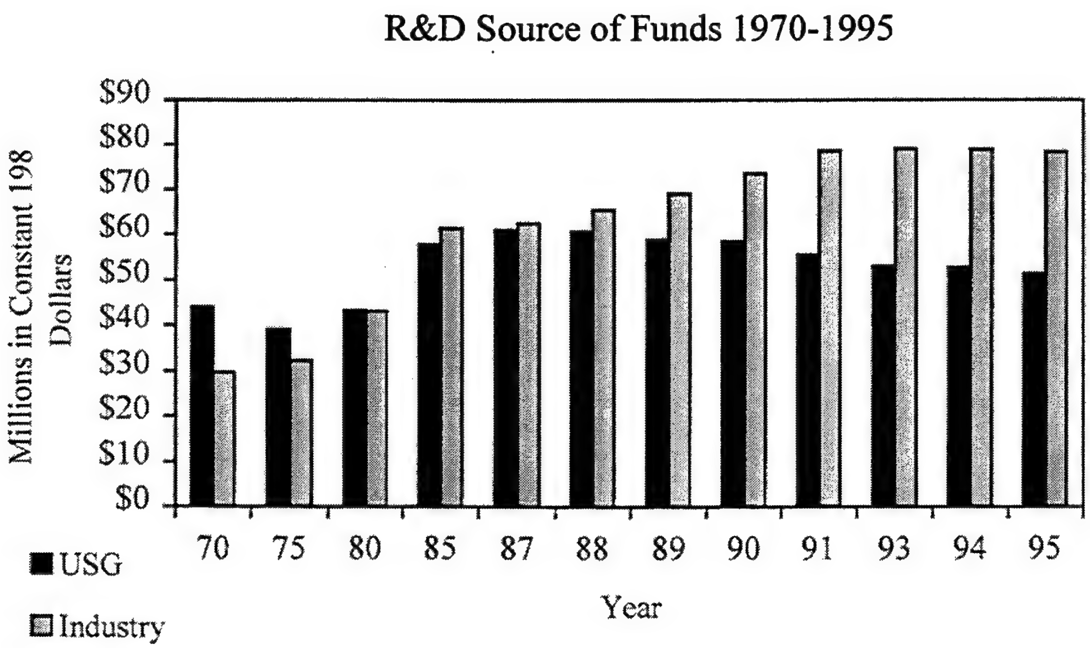

Figure 7. Sources of Research and Development Investment 1970 - 1995 (NSF, 1998:4)

1987 and fueled the development of military products. The declining USG support since that year, depicted in Figure 7, has done little to bridge the gap between basic and applied

research and their transfer to the commercial environment. The gradual decrease of federal investment has seen a gradual increase in industrial funding of research and development activities. Laboratories in educational institutions doing basic research have not found the support from industry unless there is significant opportunity for commercial application.

The lack of support for research and development activities can be interpreted as a barrier that affects the product-content and mode possibilities available to the firm. In competitive markets, as firms wishing to transfer technologies are forced to allocate greater funding for pre-commercial activity, a smaller piece of the financial pie is available for foreign direct investment. Lockheed-Martin and Boeing corporate data on research and development funding was not available for analysis. However, as the top two defense contractors world-wide, it is not unreasonable to assume that the loss of USG defense related research has resulted in similar patterns of increase in their corporate funding for research and development activities.

The drop in USG funding of industrial pre-commercial research and development is representative of the supplying nation to supplying firm relationship. The loss is viewed as a barrier to success in T^2 efforts and effects are seen in both content and mode. The product content is affected by the reduced amount of research being done. Firms are responsive to their investors and have greater difficulty justifying long-term research requirements that may or may not lead to increased profit. Accordingly, Figure 7 indicates that industrial financing has leveled off as USG support continues to decline. Regardless, industry is contributing a greater percentage of resources to the pre-commercial research and development effort. With more of the firm's dollars going

toward research and development activities, less money is available for foreign direct investment and this affects the mode of transfer. As the perceived threat of large-scale military engagement continues to diminish, the USG will continue to face domestic pressure to invest in social entitlement programs rather defense related research and development. USG current strategies support its dominant motivation to answer to public pressure.

Supplying Firm/Receiving Nation. From the firm's perspective its strategy of increased investment in commercial application research and development should allow them to transfer the technology more easily since they will not be subject to the military technology approval and export process. Unfortunately, the USG is increasingly concerned with dual-use applications of commercial technology and that benefit of the commercial application may be short-lived. Regardless, Boeing Corporation announced a research collaboration with the Polish Instytut Lotnictwa (Institute of Aviation) in "advanced research and product development ... including materials testing, composite and material technologies, wind tunnel testing, analysis software and related subjects" (Boeing, 1997:1).

By establishing long term research agreements in Poland, Boeing encourages continuing opportunity for commercial application of their research product. These actions represent evidence of the supplying firm to receiving nation relationship in the revised model for the transfer of technology and signify a bonding action that will affect people, product, and process content. Boeing's investment may result in both military and commercial applications and can affect the mode in that long term commitment to research will allow increase opportunity for diverse modes of contractual agreements.

Boeing's strategies are in response to the firm's motivation for increased sales, more equitable trade agreements, and increased sales of technology.

Receiving Nation/Receiving Firm. The Polish government's research and development efforts are largely focused in the Polish Academy of Sciences which "is a remnant of Soviet scientific policy" (USAID Report, 1997:A-25). This institution is philosophically opposed to the transfer of technology to the commercial environment. It would appear then that the Polish Academy is in favor of basic scientific research. Although this should be a boon for pre-commercial research, the monies allocated for research and development are poorly managed. Of the monies available, "70 percent is earmarked for salaries or institutional subsidies, and of the 71,000 people employed in the nation's research centers, only 12,000 are qualified scientists; the remaining 59,000 are support staff"(USAID Report, 1997:A-39). As a dispenser of research funds, the Polish Academy of Sciences is not encouraging the commercial application of its product.

> The Polish Academy of Sciences controls state research funds...and allocate[s] funds primarily to generic research proposals with no accountability for results, and with no liaison to industry. ... The academic community does not, by and large, interact with private industry. This breech is reinforced by a strong ownership by universities of "rights" to research generated by professors who are therefore reluctant to consider industrial applications. (USAID Report, 1997:A38-39)

It may be the case that the Polish government's independent endowment of $100 million to the Foundation for Polish Science to encourage T^2 was a strategic response to the perceived problems with the Academy of Sciences. But, without overarching and meaningful investment by the Polish government in research and development activities,

the responsibility falls to Polish firms. Dariusz Styczek, (1997:1) a writer for the Warsaw Voice reports that, "In Poland, companies spend $46 per capita on R&D [research and development], while the expenses in Germany and France are over $450, $300 in Finland, Denmark and Austria and $56 in Hungary." This information is corroborated in the USAID report.

> Overall, Poland is not generating a level of research investment comparable to the EU or to the pace that exists in North America or Asia. At a rate of .5 percent of GDP, Poland's support for all research in all sectors, is one-fifth that of the EU average, and even less than ...North American nations. (USAID Report, 1997:A-39)

The entrenched lack of government funding for pre-commercial research and development in conjunction with lack of communication between academic institutions and industry exemplifies the receiving nation to receiving firm relationship in the revised T^2 model. These actions constitute a barrier to the content in that the technology advancement never makes it to a product application and in the mode of transfer in that firms must invest their own funds in research and development and as a result have less money to invest in joint-ventures with foreign firms.

Synopsis. The actions of the U.S. and Polish governments (supplying and receiving nations) toward their respective firms are not seen to represent activities that Lee (1994) suggests will encourage the transfer of technology. In fact, the reduced or misappropriated funding create barriers that affect content and mode of transfer. Both governmental strategies are responding to intra-national concerns. The USG under pressure to spend the supposed peace dividend on social programs is cutting research and development in its defense programs. Poland is hard pressed to justify research and

development investment when the country's infrastructure must be rebuilt to compete for scarce resources in the global economy. Boeing Corporation's investment in Polish pre-commercial research and development is categorized as a bonding action that will affect the possibilities for content and mode of transfer. The traditional supplier/recipient model would address the relationship between Boeing and Poland, but would not take into consideration the barriers created by the reduction of investment by the U.S. government or lack of investment by Poland.

Action 3) Converting Dual-use Military Technologies. From the 1945 to 1987, the USG was the primary investor in research and development in the United States. Much of the resulting technology was created for military application. With reductions in military weapons purchases, the USG found itself in the possession of an over-abundance of military technology with less and less opportunity for application. During the same period with less business from the military, and increasing involvement in the global economy, U.S. defense firms looked for opportunities to turn military technology into a commercial product. As a result, these firms lobbied the USG for increased conversion of military technology to the commercial environment and changes to export regulations to facilitate their involvement in the global economy. By converting the military technology and passing it to the firms, the responsibility for oversight and protection by the USG is reduced and government dollars can be freed for other programs. The collected data confirmed the supplying nation to supplying firm relationship for this action. Comments are supplied on the supplying firm to receiving nation and receiving nation to receiving firm relationships.

Supplying Nation/Supplying Firm. A series of federal acts beginning in 1984 resulted in actions that began and continue to provide encouragement to USG labs and corporations to participate in the conversion of military technology to commercial application. Table 2 lists the acts and the results of their implementation.

All of the acts and executive orders communicated to the science and technology communities, the importance of integrating their efforts to convert military and/or dual-use technologies from laboratories to commercial business through Cooperative Research and Development Agreements. The provisions created model programs and encouraged the establishment of linkages to all levels of federal, state, and local government entities. The success of the efforts has been questioned because many types of military technology have limited application in the commercial environment. Given this, most federal labs have been able to successfully engage in the conversion process at some level.

The USG actions illustrate the supplying nation to supplying firm relationship in the revised T_2 model because the intention was to allow U.S. firms an increased opportunity for the application of new technologies to a commercial product. Commercial products allow for contract agreements that are not subject to the USG military license approval process. These activities are interpreted as a bonding activity between the commercial firms and USG labs as the possibilities for product and process content of the technology and modes of transfer. The USG strategy of conversion is in response to the desire of firms to capitalize on the research and development product and the USG need for a revitalized defense industrial base.

Other Relationships. Data for the corporate activities for supplying firm to receiving nation and receiving firm were not available from Lockheed-Martin or Boeing

Table 2. USG Acts and Executive Orders (Lee, 1994:263-264)

	USG Federal Acts and Executive Orders
1984	Cooperative Research Act
	Eliminated damage aspect of antitrust concerns so the interested firms, universities, and federal labs might pool scientific resources and engage in joint pre-competitive R&D. Resulted in development of two corporations.
1986	Federal Technology Transfer Act
	Authorized government-owned and operated labs to enter into cooperative R&D agreements (CRDAs) and negotiate licensing agreements.
1987	Executive Orders 12591 and 12618
	Promoted the commercializations of federal technological resources.
1988	Omnibus Trade and Competitiveness Act
	Established centers for transferring manufacturing technology.
1989	National Competitiveness Technology Transfer Act
	Extended CRDA authority to all federal labs including government-owned contractor-operated
1991	Defense Authorization Act
	Establish model programs for national defense labs to develop linkages to state and local governments and small businesses. Implemented a national Defense Manufacturing Technology Plan.
1993	Defense Authorization Act
	Authorized Defense Advanced Research Projects Agency (DARPA) to emphasize the transfer of dual-use military technology for industrial use.

Corporations. Lockheed-Martin's focus is primarily if not exclusively military applications of technology. Thus, they are less likely to be motivated to convert military technology to commercial products. Any commercial applications by Boeing remain proprietary in light of their desire for commercial competitiveness. This information may actually be disguised. If supplying nation to supplying firm relationships for conversion of military technology to commercial environment are fruitful, the T^2 is commercial from supplying firm to receiving nation and firm.

When the decision to convert military technology is made, the supplying nation has control of the conversion not the receiving nation. It is possible that Poland has military technology that they would like U.S. firms assistance to transfer to commercial products, but this would change Poland's status from a receiver to a supplier and receiver. This change in status would add an extra layer of complexity to the analysis. It is important to note that the revised T^2 model is flexible enough to explain these changing relationships eventhough the data did not provide evidence that they exist.

The discussion on the Polish Academy of Sciences's support for conversion of pre-commercial research and development suggests that conversion of military technologies (i.e., pre-commercial technologies) may be a discouraged practice in Poland. No data was found to confirm the receiving nation to receiving firm relationship relative to this activity. The lack of data may indicate a barrier activity as the void may represent Polish government policy. This possibility may be a topic for future research.

Synopsis. The described USG actions are an example of activities which Lee (1994) suggests will encourage successful transfer of technology from military to commercial use. These participants in T^2 are motivated to achieve strategic goals that

will ensure their economic and political survival by providing increased support for the conversion of military and dual-use technologies to the commercial environment. The relationship (i.e., supplying nation/supplying firm) activities are bonding actions and are not accounted for in the traditional T^2 models.

Action 4) Reforming Laws, Rules, Procedures, and Cultures that Interfere with T^2. Technology transfer does not take place in isolation, but in the rich organizational matrix of political and economic considerations that encourage or inhibit its existence. The increasingly interconnected nature of political and economic systems world-wide make participant's effort at reform seem ineffective unless they are viewed in a reciprocating environment of revised model for T^2. Now each action by a participant becomes a multiplier in the network of reforms and builds a momentum that is both apparent and effective. The following incidents will recognize supplying nation/receiving nation, supplying nation/firm, receiving nation/firm, and receiving nation/supplying firm relationships in the context of reforming laws, rules, procedures, and cultures that may interfere with T^2.

Supplying Nation/Receiving Nation. The U.S. Senate vote to ratify the protocols for Poland's accession to NATO is an example of the supplying nation to receiving nation relationship in the revised T^2 model. The USG actions represent bonding activity in that they are attempting encourage the content and modes of transfer. With admission to NATO, Poland will gain access to additional military people, process, and product content. The types of modes will be increased because co-production and co-development, joint ventures, and licensing modes can be entertained by both the supplying firms and the receiving nation. The USG strategies are in response to pressure

from corporations and the desire to stabilize the Polish democracy through NATO membership.

Supplying Nation/Supplying Firm. Department of Commerce, Bureau of Export Administration's (BXA) mission is to aid industry in obtaining the licenses necessary for the transfer of dual-use technologies. This process had been identified by industry as cumbersome and ineffective in answering their need to respond rapidly to international market demands. Under the reform efforts stretching from 1993 to 1996, BXA instituted a number of initiatives that are credited as reforms of laws, rules, and procedures. According to William A. Reinsch, Under Secretary of Commerce for BXA, the bureau accomplished the actions in Table 3 that contributed to reforms in the T^2 process during that period.

The BXA activities represent the supplying nation to supplying firm relationship in the revised T^2 model and constitute a bonding actions that affect the content and mode of transfer. By reducing the problems firms encounter in the export process, BXA has encouraged the process of T^2 and engaged in Lee's (1994) actions. BXA 's strategy is in response to growing pressure from firms and the USG to make the process simpler and provide companies greater opportunity for increased sales.

Supplying Firm/Supplying Nation. Lockheed-Martin and Boeing

Corporations have actively lobbied (Seelye, 1998) to promote the expansion of NATO in an effort to expand their markets, these corporations work to reform rules and laws thereby diminishing the barriers that inhibit T^2. The Aerospace Industries Association (AIA, 1998b) at their web site lists the top ten issues affecting the ability of

Table 3. BXA Actions Encouraging Successful T^2 (Reinsch, 1996)

Dept. of Commerce, Bureau of Export Administration Actions	
1)	Liberalized controls on high performance computers
2)	Clarified and simplified the EAR making it user friendly
3)	Obtained a Presidential Executive Order that improved the export license process
4)	Successfully transferred commercial communication satellites and jet engine technology jurisdiction from the State Department to the Commerce Department Control List
5)	Simplified the license process for U.S. industries to export nuclear-controlled items via license exception to an expanded number of countries
6)	Liberalized chemical export regulations
7)	Developed a Special Comprehensive License for experienced, high volume exporters

industry members, Lockheed-Martin and Boeing Corporations, to compete effectively. Joel L. Johnson, Vice President, International AIA appeared before the subcommittee on International Economic Police, Export and Trade Promotion, U.S. Senate Committee on Foreign Relations in April 1996 to plead AIA's case for support of export financing for foreign countries wishing to purchase U.S. products (Johnson, 1996:1). AIA also advocated that the U.S. drop unilateral trade restriction because it impedes U.S. firms' competitiveness (AIA, 1998a). This type of industry visibility is not inexpensive. Corporations survive by profit and do not put money to projects that offer little

opportunity for return. Some dispute exists on the effectiveness of industrial lobbying efforts, but in April 1998, the Senate voted to ratify the NATO Protocols for Poland with little or no dissention.

These corporate lobbying efforts represent the reciprocal supplying firm to supplying nation relationship called out in the revised T^2 model. Their actions are attempts at reducing the barriers that prevent them from capitalizing on international opportunities for profit. As such, they are attempting to affect the mode and content of transfer available to them under current law and policies. Their corporate strategies are motivated by desire for increased sales and profitability.

Receiving Nation/Receiving Firm. Since 1989, Poland has enacted numerous legal reforms in an effort to establish and maintain a market economy. By passing new government procurement law in 1994, Poland is now in accordance with the United Nations Model Procurement Code. This code requires competition, transparency, and public announcements, and provides legal recourse for bribery. The Labor Code, effective in June 1996, guaranteed workers the right to form unions, to organize and bargain collectively, prohibited forced or compulsory labor, established a minimum work age, and defined acceptable working conditions (U.S. Dept. of State, 1997:7-8).

These actions illustrate the receiving nation to receiving firm relationship in the revised T^2 model and are a bonding activity. By insuring protection of its citizens in the workplace, the Polish government affects the people-embodied content of the transfer process. The legal foundations of procurement process affect the modes of transfer for the receiving firms in that contractual actions are upheld by a code of law. Poland's strategies conform to Lee's activities that encourage the transfer of technology and

respond to that country's motivation to increase Polish firms profitability and encourage economic growth.

Receiving Nation/Supplying Firm. "The Polish government has made major strides in improving protection of intellectual property rights" (Department of State, 1997:6). Poland's efforts include a new copyright law in 1994, tighter penalties for companies who misuse registered trademarks, adherence to the Berne Convention for the Protection of Literary and Artistic Works, and the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights. The U.S. and Poland signed a bilateral Business and Economic Relations Treaty, which contains provisions on the protection of U.S. intellectual property. This treaty came into effect after Poland significantly improved the level of protection of copyright in the country. In combination, these laws and conventions provide a better umbrella of protection for U.S. firms' intellectual property.

Poland's actions depict the receiving nation to supplying firm relationship in the revised T^2 model. The institutionalized protection of U.S. firms' intellectual property by Poland is a bonding activity. It affects the product, people and process aspects of content by allowing U.S. firms the protection under the law from the abuse of their intellectual property. This protection should encourage supplying firms to engage in the transfer of technology. As property right protection is usually called out in contractual agreements, Polish legal protection affects the licensing mode by guaranteeing the owners of intellectual property legal recourse if the licensing agreement is not supported in fact. Poland's strategies are in response to national motivations to encourage T^2, and increase economic growth and tax revenues.

Synopsis. The described actions are examples of activities that Lee (1994) suggests will encourage successful transfer of technology. These participants in T^2 are motivated to achieve strategic goals that will insure their economic and political survival by providing increased support for the reformation of laws, rules, procedures, and cultures that interfere with T^2. The relationships (i.e., supplying nation to receiving nation, reciprocal supplying nation to supplying firm and supplying firm to supplying nation, receiving nation to receiving firm, and receiving nation to supplying firm) called out in the revised T^2 model are not accounted for in the traditional supplier/recipient model.

Action 5) Creating and Empowering Partnerships Between Technology Suppliers and Technology Recipients. For successful international T^2 to occur, successful partnerships must exist. These partnerships transpire within the matrix of political and economic policies of their countries of origin. USG and Polish government policies, laws, and actions in addition to corporate actions can either encourage or inhibit the successful partnering of technology suppliers and recipients. The following data will support the existence of the supplying nation to supplying firm, supplying firm to receiving firm and receiving nation to supplying firm relationships proposed in the revised T^2 model.

Supplying Nation/Supplying Firm. The USG data revolves around the indirect empowerment of the supplier/recipient relationships. The 1995 memo from William Perry, then Secretary of Defense (See Appendix A) legitimized if not encouraged employees of the USG to bring U.S. products to the attention of foreign government administrators. This can only foster the impression of tacit of approval of

any resulting transfer of the technology between the U.S. suppliers and foreign recipients. This fact is reinforced by the history of Lockheed-Martin's offset arrangements for the F-16 (Hsiung, 1998:1). This history shows that the USG has actively supported Lockheed-Martin Corporation, in the marketing and sale of the F-16 to seventeen different countries. Lockheed-Martin has informally proposed the purchase of the F-16 to the Polish Ministry of Defense and will probable offer some variant of an offset arrangement. It follows that the USG empowers the supplier/recipient relationship in Poland through published policy and historical precedent.

By encouraging its employees to suggest the purchase of U.S. made military products to foreign governments, the USG has engaged in bonding activities that can affect the content. These actions will encourage successful T^2. The USG strategy is in response to its need to strengthen the U.S. industrial base and increase the sales of technology.

Supplying Firm/Receiving Firm. Both Lockheed-Martin and Boeing Corporations have displayed interest in the Polish military market. In November 1997, Boeing Corporation submitted a proposal and later withdrew it from a Polish contract competition for the upgrade of the Huzar helicopter (Boeing, 1997). Elbit Systems Ltd, an Israeli firm, won the contract in December 1997. In late January 1998, Lockheed-Martin announced that they were "drafting a cooperation plan for future joint business" with Elbit Systems Ltd. A Lockheed-Martin official stated that "opportunities focus on the upgrades to F-16's around the world" (Lockheed, 1998b). Many European nations currently have the F-16s in their military inventories. Several NATO nations have cooperated in F-16 productions efforts. Lockheed-Martin's choice of joint-venture

partner is then purposeful given that Elbit has had a business history in the EU. It appears that Lockheed-Martin has tried to capitalize on Elbit's insider status (in both the EU and Poland) by forming a joint venture with them. Should Poland choose to purchase the F-16, Lockheed-Martin will have an existing joint venture relationship to aid them in their business activities in that country and throughout the EU.

Lockheed-Martin's activities represent the supplying firm to receiving firm relationship. This action is a strategic choice that creates partnerships between suppliers and recipients and represents bonding actions that affect the mode of transfer and encourage successful T^2. Lockheed-Martin's strategy is in response to its need to facilitate more equitable trade agreements and improve their profitability.

Receiving Nation/Supplying Firm. Poland has created 17 enterprise zones to encourage the investment by foreign firms. Three of the zones are active (i.e., Katowice, Gdansk, and Mielec) and are located in areas of high unemployment like Mielec or are set up adjacent to expected sites for foreign corporate production. Various tax and financial incentives, including "real estate tax exemption, company tax relief on vestment expenditures, enterprise income tax relief for job creation, and an accelerated rate of depreciation on tangible assets," are offered to firms in hopes of increasing subcontracting with Polish firms and facilitate increased T^2 (USAID Report, 1998:A-21).

Poland's activities represent the reciprocal-receiving nation to supplying firm relationship in the revised T^2 model. These actions are a strategic choice that encourages partnerships between suppliers and recipients of technology. It represents bonding actions that affect the mode of transfer and encourage successful T^2. Poland's strategy is

in response to its need to facilitate more equitable trade agreements, improve the profitability of Polish firms, and increase tax revenues.

Synopsis. The described actions are examples of activities that Lee (1994) suggests will encourage successful transfer of technology. These participants in T^2 are motivated to achieve strategic goals that will insure their economic and political survival by creating empowering partnerships between technology suppliers and technology recipients. The supplying firm to receiving firm relational bonding activities of Lockheed-Martin Corporation are accounted for in the traditions supplier/recipient model. The remaining relationships (i.e., supplying nation to supplying firm, receiving nation to supplying firm) are not accounted for in the traditional supplier/recipient model.

Action 6) Dealing with the Global Trading Environment that Impedes Technological Competitiveness. Globalization, by definition, requires openness between the different parties. Companies and countries trying to keep a technological advantage do not wish to share information for fear of loss of strategic advantage. Participants in the transfer of technology must resolve these conflicting interests. The data support the existence of the supplying nation to receiving nation and supplying firm to receiving firm relationships proposed by the revised T^2 model.

Supplying Nation/Receiving Nation. The USG has implemented changes to export administration regulations to meet the requirements of the Wassenaar Arrangement. Both the U.S. and Poland are signatories to that agreement. The intent of the Wassenaar Arrangement was to bring openness of information concerning the approval or disapproval of dual-use technologies by member countries. The arrangement meets the requirement for openness while leaving open the actions of the member

countries. The USG adoption of domestic export regulations in line with the arrangement represents the supplying nation to receiving nation relationship in the revised T^2 model. This action is a strategic choice that deals with the global trading environment that impedes technological competitiveness. It represents bonding actions that affect the content of transfer as participant seek consensus in transfer approvals and decisions. The USG strategy is in response to its need to reduce the risk to national security and seek equitable trade agreements for U.S. firms.

Supplying Firm/Receiving Firm. In February 1998, Vance Coffman, the CEO of Lockheed-Martin, delivered a speech in Munich, Germany, in which he urged increased U.S. and European industry cooperation (Lockheed, 1998a). His urgings came in recognition of the reality that intense international inter-firm competition will potentially reduce individual firm profits because competition is expensive. By co-operating the potential for sharing of information may increase and reduce the loss associated with keeping technologies away from competitors.

Lockheed-Martin's activities represent the supplying firm to receiving firm relationship in the revised T^2 model. This action is a strategic choice that deals with the global trading environment that impedes technological competitiveness between suppliers and recipients of technology. It represents bonding actions that affect the content of transfer in that Lockheed-Martin suggests open sharing of information and technology (content) in partnership with other firms (mode) as an answer to increasing global competition. Lockheed-Martin's strategy is in response to its need to facilitate more equitable trade agreements and improve the profitability.

Synopsis. The described actions are examples of activities that Lee (1994) suggests will encourage successful transfer of technology. These participants in T^2 are motivated to achieve strategic goals that will insure their economic and political survival by dealing with the global trading environment that impedes technological competitiveness. The supplying firm to receiving firm relational bonding activities of Lockheed-Martin Corporation are accounted for in the traditional supplier/recipient model. The remaining relationship (i.e., supplying nation to receiving nation) are not accounted for in the traditional supplier/recipient model.

Summary

The complex interactions among participants in the transfer of military and or dual-use technologies to Poland were found to satisfy many of the recommendations made by Lee (1994) for success T^2. Table 4 summarizes the collected research data and Table 5 verifies that each participant engaged in at least four of the actions Lee (1994) suggests will encourage successful T^2. The pattern of observations depicts a lack of participant bias for any of the six action..

The USG, as a supplying nation, has relationships that include the receiving nation and supplying firm. Lockheed-Martin and Boeing Corporations maintain relationships with the supplying nation, the receiving nation and receiving firms. The Polish government, as the receiving nation must deal with the supplying nation, the supplying firms and the receiving firms. The collected data suggest that the strategic activities of all participants are unique for the circumstance involved but are generally motivated by the organizational desire to survive and thrive. Both nations and firms

engage in bonding activities that encourage agreements and reduce barriers for content and mode of transfer.

A perfect taxonomy would allow for the labeling data in such as way as to be independent and mutually exclusive. In the case of international transfer of military and/or dual-use technologies, the bonding action between two participants can create a barrier for a different participant. Additionally, the actions between any two participants can be reciprocated in that in a single relationship (supplying nation/supplying firm) the actions can be initiated by either party.

While more complex, the revised model for international T^2 offers a more complete description of the activities of the USG, Lockheed-Martin and Boeing Corporations, and the Polish government in the transfer of military and/or dual-use technologies to Poland. The value of this enhanced description is discussed in the final chapter.

Table 4. Summary of Actions by Participants in Revised T^2 Model

Participant Barrier/Bond Actions to Content and Mode

Action/Strategy	Relationship	Content	Mode
1. Upgrading scientific and technological infrastructure	$S_N \leftrightarrow R_N$	Bond	Bond
	$S_N \leftrightarrow S_F$	-	-
	$S_F \leftrightarrow R_N$	Bond	Bond
	$S_F \leftrightarrow R_F$	-	-
	$R_N \leftrightarrow R_F$	Bond	-
2. Dealing with funding gap for pre-commercial research	$S_N \leftrightarrow R_N$	-	-
	$S_N \leftrightarrow S_F$	Barrier	Barrier
	$S_F \leftrightarrow R_N$	Bond	Bond
	$S_F \leftrightarrow R_F$	-	-
	$R_N \leftrightarrow R_F$	Barrier	Barrier
3. Converting of military and dual-use technologies for commercial use	$S_N \leftrightarrow R_N$	-	-
	$S_N \leftrightarrow S_F$	Bond	Bond
	$S_F \leftrightarrow R_N$	-	-
	$S_F \leftrightarrow R_F$	-	-
	$R_N \leftrightarrow R_F$	-	-
4. Reforming laws, bureaucratic rules, procedures, organizational cultures, and personalities that interfere with transfer processes	$S_N \leftrightarrow R_N$	Bond*	Bond*
	$S_N \leftrightarrow S_F$	Bond**	Bond
	$S_F \leftrightarrow R_N$	Bond**	Bond
	$S_F \leftrightarrow R_F$	-	-
	$R_N \leftrightarrow R_F$	Bond	Bond
5. Creating and empowering partnerships between suppliers and recipients of technology	$S_N \leftrightarrow R_N$	-	-
	$S_N \leftrightarrow S_F$	Bond	-
	$S_F \leftrightarrow R_N$	-	Bond
	$S_F \leftrightarrow R_F$	Bond	Bond
	$R_N \leftrightarrow R_F$	-	-
6. Dealing with the global trading environment that impedes technological competitiveness	$S_N \leftrightarrow R_N$	Bond	-
	$S_N \leftrightarrow S_F$	-	-
	$S_F \leftrightarrow R_N$	-	-
	$S_F \leftrightarrow R_F$	Bond	Bond
	$R_N \leftrightarrow R_F$	-	-

S_N = Supplying Nation, S_F = Supplying Firm, R_N = Receiving Nation, R_F = Receiving Firm

* Bond actions for one nation/firm can create a barrier action for a different nation/firm and vice versa.

** Reciprocal relationship observed $S_F \leftrightarrow S_N$ and $R_N \leftrightarrow S_F$ for this action.

\- Not Observed

Table 5. Participant Involvement in Lee's (1994) Actions

Participant Involvement in Lee's (1994) Actions

Action	**Participants** **U.S. Govt**	**U.S. Defense Firms**	**Polish Govt**	**Polish Firms**
1. Upgrading scientific and technological infrastructure	**X**	**X**	**X**	-
2. Dealing with funding for pre-commercial research	**X**	**X**	**X**	**X**
3. Converting military and dual-use technologies for commercial use	**X**	**X**	-	-
4. Reforming laws, bureaucratic rules, procedures, organizational cultures, and personalities that interfere with transfer processes	**X**	**X**	**X**	**X**
5. Creating and empowering partnerships between suppliers and recipients of technology	**X**	**X**	**X**	**X**
6. Dealing with the global trading environment that impedes technological competitiveness	**X**	**X**	**X**	**X**

X = Has been either the initiator or receiver in the involvement.
- Not Observed

V. Conclusions and Recommendations

Introduction

The information presented in Chapter Four provided evidence that the supplier/recipient relational model only partially describes the complex relationships between the USG, Lockheed-Martin and Boeing Corporations, the Polish government, and Polish firms in the international transfer of military and/or dual-use technologies. The revised model provided additional insight into the strategies used and the behaviors exhibited by the participants to that process. The exhibited behaviors are the result of organizational strategies that have been developed in response to unique motivations and these motivations are shaped in a complex matrix of political and economic considerations.

Conclusions

If we are depend on the traditional supplier/recipient (i.e. supplying firm to receiving firm relationship) model to describe the behaviors of the participants in transfer of military and/or dual-use technology in Poland, the amount of data that is available is extremely limited. However, including the important relationships between supplying and receiving nations and firms shed light on the processes of T^2 and enable us to tell a more complete story. The revised model provides a tool to measure the variety of activities and relationships that exist in the international network of nations and firms seeking to export and import technologies. These activities can now be collected and sorted with a reasonably clear understanding of the intentions of the participants. The

model also seems to possess the flexibility to provide insight into participant actions over time. The data was collected over ten-year range in which many political and economic changes occurred. When this data was applied to validate the model, it still produced a reasonable explanation of strategies and relationships for the participants in the T^2 process. Their decisions for content and mode of transfer were based on their perceived political and economic strengths and weaknesses relative to the other participants and the model accommodated this reality.

The USG has on-going relationships with the Polish government and U.S. defense firms. Its decision to approval the transfer of military and/or dual-use technology must be weighed against the loss of that technology to users who would threaten the U.S. national defense. In a world in increasing terrorist activity, this concern will not decrease. Despite these concerns, the information in Table 4 and 5 indicates that the USG is engaging in bonding actions that encourage the transfer of military and/or dual-use technologies to Poland. The data that relates to barrier activity in the investment in pre-commercial research falls into the "guns or butter" decision. The dominant mood within the U.S. is to attend to domestic needs found in entitlement programs. The funding available to the Defense Department for research and development is discretionary. Legislators do not seem inclined to increase discretionary spending at the perceived expense of the constituents that support them. Therefore, the trends identified for sources of research and development funding will probably continue and firms will continue to take the lead in the pre-commercial research effort.

Lockheed-Martin and Boeing Corporations have relationships with the USG, the Polish government, and Polish firms. Each decision they make to transfer technology to

Poland will be done with a systematic weighing of the business opportunities and threats to their competitive advantage. Tables 4 and 5 indicate that these defense firms are choosing to participate in bonding activities for all of the actions that Lee suggests are necessary for successful T^2. The majority of their activities are found in the investments for the scientific and technological infrastructure and pre-commercial research and development. They are actively involved in reforming laws and procedures that interfere with T^2 and creating and empowering partnerships. In a global economy, these activities are the first line of action for firms seeking to enter emerging markets whether those market be domestic or foreign. By engaging with the governments and firms they extend the range of their influence and afford themselves ever-increasing business opportunities.

The EU has seen a wave of company mergers (Hoschouer, 1997:3) in recent months as European defense industries experience increasing competition in the global economy. A 10 percent profit margin for American defense contractors is not uncommon while European contractors "are yielding abut six percent operating profits" (Finnegan, 1998a). Given the need for economies of scale to increase competitiveness, the ground may be fertile for Lockheed-Martin's suggestions on future joint U.S.and European business ventures. This relationship may become even more complex as firms on both continents attempt foreign direct investment and U.S.--European divide gives way to a global aerospace industry.

Poland has T^2 relationships with the USG, U.S. firms, and Polish firms. Decisions to transfer technology from the U.S. opens up opportunities for Polish workers and will contribute to overall economic growth. The data summary in Tables 4 and 5 indicate that Poland has chosen to encourage T^2 with few exceptions. The barrier

activities under investment in pre-commercial research and development are an artifact of the impoverished state of most of the Eastern bloc nations. The luxury associated with this type of investment, given the current state of the Polish infrastructure, is outside the near-term financial capability of the country. The fact that enterprise and T^2 zones have been established indicates that Poland is prepared to invest when monies become available.

Polish firms are beginning to gain the expertise required to participate successfully in the growing market economy. They have few resources for investment either in the scientific and technological infrastructure or pre-commercial research and development. Their dependence on government and foreign firm support will continue for some period of time in the future. "In a global environment, and specifically in light of Poland's prospects for EU membership and inclusion in NATO, the country must have access to international technological developments, foreign markets, and potential alliance investors" (USAID, 1998:A-40). The importation of military and/or dual-use technologies answers all these requirements and can provide the needed improvements for Poland's defense capability.

Participants in the T^2 process work with each other (and sometimes against each other) in order to take advantage of bonds and reduce barriers to increase the content available for technology and the modes in which it can be transferred. Supplier nations and receiving nations present political and economic challenges to the corporations choosing to engage in international T^2. The armament decisions made by Poland and pressures exerted by the USG, EU, and U.S. corporations will affect the continued strength of the U.S. defense industrial base as Defense Department contractors face

increased competition for military products in the global economy. As other eastern European nation-states seek admission to NATO and the EU and armament sales increase, the USG must have a clear understanding of the political and economic strategies that influence these armament decisions. "Control over technology is an instrument to accumulate economic and political power and to steer transnational relations" (Todd, 1986:208). The USG holds the reins of the transfer process of military and/or dual-use technologies. It must steer a course that avoids threats to its national security while allowing U.S. firms to effectively and efficiently ride the wave of the global economy.

Research Limitations

The data available for exploration of behaviors of Lockheed-Martin and Boeing Corporations (i.e., supplying firms) was confined to information found newspaper articles, press releases, and various world-wide-web sites. This information provides some insight into their goals, strategies to achieve those goals, and behaviors in their relationships. Unfortunately, these data sources limit the validity of the research. The availability of additional data sources may increase as a function of time. As corporate desires to limit information flow concerning strategic behaviors to gain market share in Poland are reduced, these corporations may be more forthcoming with interview data.

In addition, the data collected represent mostly bond activities. The complex nature of the relationships and differences in participant motives suggests that the examples of barrier activities would be just as numerous. One possible explanation for the reduced number of barriers is the bias the researcher had in selecting samples for the

data. The intent of the data search was to find examples of Lee's (1994) six actions. These actions each represent strategies that participants can take to increase the bonds and reduce barriers. Since T^2 is generally seen as a positive action, participants are more likely to exhibit behaviors and advertise strategies encouraging successful transfer. The barriers identified were incidental to the actions that the participants took to negate them. Methods to uncover more barriers could include personal interviews or surveys. However, the researcher must be able to establish the trust necessary for answers to be forthcoming. Thus, the research is limited in that it does not represent the full scope of participant barrier activities.

Recommendations for Future Research

The limitations previously discussed provide many recommendations for extending the application of the revised T^2 model. This research effort should be submitted to Lockheed-Martin and Boeing Corporations, as an exploratory study in hopes of eliciting additional data for increasing the validity of the revised T^2 model. Future research should include validation of the revised model for international T^2 with application to other countries seeking admission to NATO. Specifically, as the Czech Republic and Hungary seek additional access to U.S. military and/or dual-use technologies, the revised model could be used to explore participant behaviors and relationships in an attempt to define participant goals and strategies that encourage successful T^2.

The current research effort did not uncover data concerning the conversion of Polish military technology to the commercial environment. Polish industry has a history of military production and military technology whether it be people, product, or process-

embodied associated with it. An extension of the current research should include an investigations of the opportunities for this type of supplying nation/firm relationship. To accomplish this end, the researcher would need the support and sponsorship of the Polish Ministry of Defense. Should data become available, the opportunity for Poland to capitalize on its own technology may increase.

The real test of the model will be its application in other countries where the receiving nation has less proximity to western economic and political systems. A real challenge would be an application of the revised model to T^2 in China, a country with far less experience in western political and economic systems. Boisot and Child (1996:604) have already identified the fact that the Chinese markets, absent traditional western influences, has established a form of Chinese network capitalism. In this environment, a different set of relationship dynamics guide the decisions of domestic and foreign entrepreneurs. With this in mind, the test of model flexibility would rest with an exploration of those relationships and the strategies which provide an avenue for successful T^2 in China.

Appendix A.

Policy on Encouraging Foreign Governments

to Procure From U.S. Sources

By

William J. Perry
Secretary of Defense

[The following memorandum, dated 21 July 95, subject as above, was furnished to the addressees listed below.]

Departmental personnel may be requested to send recommendations regarding particular firms or their products to foreign governments. It is the general policy of the Department of Defense to encourage foreign governments to buy American defense-related products when sales of such products are consistent with United States national security and foreign policy interests and the products are authorized by the United States Government for international marketing or export. Officials of the Department of Defense should not endorse specific commercial firms or products or recommend specific commercial firms or products to prospective purchasers except when the conditions above are met and under the following circumstances.

Addressees may encourage allied and friendly foreign governments to purchase the same defense equipment or supplies that are used by the Department of Defense (i.e., standard equipment or supplies) in order to further the United States interest in standardization and interoperability with the armed forces of allied and friendly nations.

Addressees may also encourage allied and friendly foreign governments to purchase non-standard defense equipment or supplies of American firms, including equipment and supplies previously used by the Department of Defense but no longer in inventory, when the non-standard equipment and supplies are more suitable to the mutual security interests of the United States and the foreign governments.

Addressees may also encourage foreign governments to purchase goods or services from a particular American firm if the firm's goods or services will meet the purchaser's requirements and where it has been verified that the firm is the only American firm competing for a foreign purchase. No recommendation should be

made where the Department's experience with the firm and its products have been unsatisfactory.

Generally, care should be taken not to support one American firm over another.

Any exception to this policy must be approved by the Secretary, the Deputy Secretary of Defense, or the Under Secretary of Defense for Acquisition and Technology.

Addressee List: Secretaries of the Military Departments
Chairman of the Joint Chiefs of Staff
Under Secretaries of Defense
Director, Defense Research and Engineering
Assistant Secretaries of Defense
Director, Operational Test and Evaluation
Directors of the Defense Agencies

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This case study examines how U.S. Government (USAF) policy, U.S. corporate policy, and Polish government policy affect the strategy of technology transfer of military and/or dual-use technologies in Poland. The traditional supplier/recipient relationship is explored and found to be insufficient to describe the process associated with military and/or dual-use technology transfer. An alternate model is proposed that accounts for the activities of the USAF, U.S. corporations, and the Polish government. These relationships are investigated in the context of six strategies to determine the validity of the model in the case of military and/or dual-use technology transfer to Poland. The analysis provides evidence that in an increasingly globalized economy, appropriate strategies for technology transfer are critical for each participant to attain their particular objectives. Further, these strategies are influenced by intra-participant forces that shape goals and inter-participant relations that both create and inhibit opportunities to transfer technology.

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